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# JEE ADVANCED 2026

17 MAY 2026 - Paper 1

**TOPPERS ARE NOT BORN,  
THEY'RE MADE @ SRI CHAITANYA**

**JEE MAIN 2025**



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**JEE ADV 2025**



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# WHEN THE GOAL IS SET AT SRI CHAITANYA, THE RESULT IS NO. 1

India's only institution with two AIR 1s in JEE MAIN 2026



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**8**  
AIR  
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**11**  
AIR  
**YASHWARDHAN**  
APPL. NO. 260310789895\*

**15**  
AIR  
**J R MANIDEEP REDDY**  
APPL. NO. 260310032718  
Sri Chaitanya

**SEIZES 5 RANKS IN TOP 15 IN ALL INDIA OPEN CATEGORY**

**27 RANKS  
BELOW 100 IN  
ALL INDIA  
OPEN CATEGORY**

**22**  
RANK  
**ARNAV GANDHI**  
APPL. NO. 260310032923

**23**  
RANK  
**SHREYAS MISHRA**  
APPL. NO. 260310038981\*

**30**  
RANK  
**SHRESTH JASORIA**  
APPL. NO. 26031017628\*

**32**  
RANK  
**AARUSH GOEL**  
APPL. NO. 260310035263\*

**46**  
RANK  
**NISKARSH VERMA**  
APPL. NO. 260310012748

**46**  
RANK  
**KATA HIMAKAR**  
APPL. NO. 260310178198

**48**  
RANK  
**RUCHIT AGRAWAL**  
APPL. NO. 260310175846\*

**52**  
RANK  
**T JASHWANTH REDDY**  
APPL. NO. 26031020180

**54**  
RANK  
**GANNI SAI SATHVIK**  
APPL. NO. 260310098440

**55**  
RANK  
**KUNTAL CHOUDHURY**  
APPL. NO. 260310384382\*

**57**  
RANK  
**A SUSHANT KUMAR**  
APPL. NO. 260310173447\*

**58**  
RANK  
**P BHARGAV NAIDU**  
APPL. NO. 260310428312

**60**  
RANK  
**PANAKA RAM SUBHASH**  
APPL. NO. 260310301035

**62**  
RANK  
**M RAMA SANTHOSH**  
APPL. NO. 260310178289

**70**  
RANK  
**S NIKHILESH KESANI**  
APPL. NO. 26031101556

**73**  
RANK  
**LAKSHIT SINSINWAR**  
APPL. NO. 26031877688\*

**79**  
RANK  
**B SAMEERAJ REDDY**  
APPL. NO. 260310704062

**80**  
RANK  
**MUKKARA SAKETH**  
APPL. NO. 260310180924

**83**  
RANK  
**P CHENNA KESAV**  
APPL. NO. 260310184531

**85**  
RANK  
**M NAGA SAHARSHA**  
APPL. NO. 260310177318

**87**  
RANK  
**ADITYA SINGH**  
APPL. NO. 260310067828

**100**  
RANK  
**YAJAT SHINGHAL**  
APPL. NO. 260310228683

BELOW  
100  
ALL INDIA OPEN  
CATEGORY RANKS

**27**

BELOW  
1000  
ALL INDIA OPEN  
CATEGORY RANKS

**172**

BELOW  
100  
ALL INDIA CATEGORY  
RANKS COUNT

**95**

BELOW  
1000  
ALL INDIA CATEGORY  
RANKS COUNT

**640**

TOTAL QUALIFIED RANKS  
FOR JEE ADVANCED - 2026  
**24,700**





# Sri Chaitanya IIT Academy., India.

A.P. T.S. KARNATAKA TAMILNADU MAHARASTRA DELHI RANCHI

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ICON Central Office - Madhapur – Hyderabad

## JEE-ADVANCED-2026-P1-Model

Time:3Hr's

**IMPORTANT INSTRUCTIONS**

Max Marks: 180

### MATHEMATICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 4)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 5 – 8)	Questions with Multiple Correct Choice with partial mark	+4	-1	4	16
Sec – III(Q.N : 9 – 12)	Questions with NUMERICAL VALUE Type	+4	0	4	16
Sec – IV(Q.N : 13 – 16)	Matching Type	+4	-1	4	16
<b>Total</b>				<b>16</b>	<b>60</b>

### PHYSICS:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 17 – 20)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 21 – 24)	Questions with Multiple Correct Choice with partial mark	+4	-1	4	16
Sec – III(Q.N : 25 – 28)	Questions with NUMERICAL VALUE Type	+4	0	4	16
Sec – IV(Q.N : 29 – 32)	Matching Type	+4	-1	4	16
<b>Total</b>				<b>16</b>	<b>60</b>

### CHEMISTRY:

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 33 – 36)	Questions with Single Correct Choice	+3	-1	4	12
Sec – II(Q.N : 37 – 40)	Questions with Multiple Correct Choice with partial mark	+4	-1	4	16
Sec – III(Q.N : 41 – 44)	Questions with NUMERICAL VALUE Type	+4	0	4	16
Sec – IV(Q.N : 45 – 48)	Matching Type	+4	-1	4	16
<b>Total</b>				<b>16</b>	<b>60</b>

**HISTORY CREATED 300/300 IN JEE MAIN  
4<sup>TH</sup> YEAR IN A ROW**

**CONSISTENCY ISN'T LUCK. IT'S CULTURE.**

## MATHEMATICS

Max Marks: 60

SECTION – I  
(SINGLE CORRECT ANSWER TYPE)This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

**Full Marks** : +3 If **ONLY** the correct option is chosen;**Zero Marks** : 0 If none of the options is chosen (i.e. the question is unanswered);**Negative Marks** : -1 In all other cases1. Consider the function  $f : (0, \infty) \rightarrow (-\infty, \infty)$  given by

$$f(x) = \sqrt{x} \log_e(x) - x + 1$$

Then which one of the following statements is **TRUE**?

- A) The derivative of the function  $f$  is decreasing in the interval  $(0, 1)$
- B) The function  $f$  has a local maximum at some point  $a \in (0, \infty)$
- C) The  $f$  has a local minimum at some point  $b \in (0, \infty)$
- D) The function  $f$  has **NEITHER** a point of local maximum **NOR** a point of local minimum in the interval  $(0, \infty)$

**Ans. D**

**Sol.**  $f(x) = \sqrt{x} \ln x - x + 1$

$$f'(x) = \frac{1}{2\sqrt{x}} \ln x + \frac{\sqrt{x}}{x} - 1$$

$$f'(x) = \frac{\ln x + 2 - 2\sqrt{x}}{2\sqrt{x}}$$

$$H(x) = \ln x + 2 - 2\sqrt{x}$$

$$H'(x) = \frac{1}{x} - \frac{2}{2\sqrt{x}} = \frac{1}{x} - \frac{1}{\sqrt{x}} = \frac{1 - \sqrt{x}}{x}$$

$$x < 1 \quad I \quad x = 1 \quad \text{maxima}$$

$$x > 1 \quad D \quad x(1) = 0 \quad f'(x) < 0$$



2. Let  $P$  be the point on the parabola  $y = x^2$  such that the slope of the tangent to the parabola at the point  $P$  is 4. Let  $Q$  be the point in the first quadrant lying on the circle  $x^2 + y^2 = 2$  such that the slope of the tangent to the circle at the point  $Q$  is  $-1$ . Let  $R$  be the point in the first quadrant lying on the ellipse  $x^2 + 4y^2 = 8$  such that the slope of the tangent to the ellipse at the point  $R$  is  $-\frac{1}{2}$ . Then the radius of the circle passing through the points  $P, Q$  and  $R$  is

- A)  $\sqrt{10}$       B)  $\sqrt{5}$       C)  $\sqrt{\frac{5}{2}}$       D)  $2\sqrt{5}$

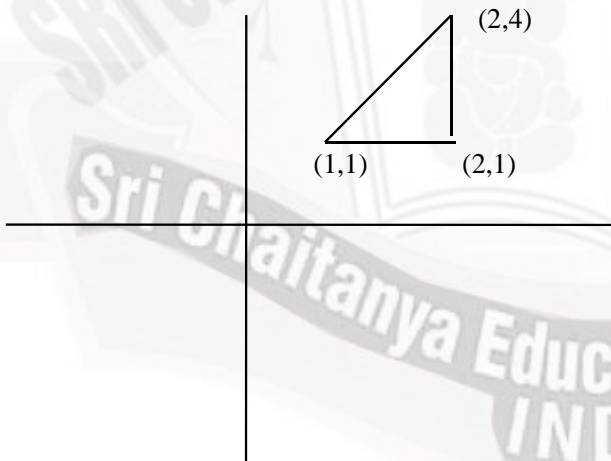
Ans. C

Sol.  $x^2 = y$

$$P\left(\frac{t}{2}, \frac{t^2}{4}\right) \quad y' = t \Rightarrow t = 4 \Rightarrow P(2, 4), \quad y' = \frac{-x}{y}$$

$$Q(\sqrt{2} \cos \theta, \sqrt{2} \sin \theta) \Rightarrow \tan \theta = 1 \Rightarrow Q(1, 1)$$

$$R(2\sqrt{2} \cos \phi, \sqrt{2} \sin \phi) \Rightarrow \cot \phi = 1 \Rightarrow R(2, 1)$$



$$r = \frac{\sqrt{10}}{2} = \sqrt{\frac{5}{4}}$$

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3. Which one of the following matrices can be obtained by performing elementary row transformations on the  $3 \times 3$  identity matrix?

A)  $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$       B)  $\begin{bmatrix} 1 & 1 & 1 \\ 2 & 3 & 4 \\ 1 & 2 & 1 \end{bmatrix}$       C)  $\begin{bmatrix} 1 & 1 & 1 \\ 2 & 3 & 4 \\ 2 & 5 & 8 \end{bmatrix}$       D)  $\begin{bmatrix} 1 & 1 & 1 \\ -1 & 1 & 2 \\ 0 & 2 & 3 \end{bmatrix}$

Ans. B

Sol. If A is a matrix and B be the matrix obtained by some row transformations, then  $|A| = |B|$

A)  $\det = 0$       B)  $\det \neq 0$       C)  $\det = 0$       D)  $\det = 0$

4. Considering only the principal values of the inverse trigonometric functions, the value of

$$\cot^{-1}(\cot(-11)) + 10 \sin\left(2 \cos^{-1}\left(\frac{1}{\sqrt{2}}\right)\right) + 10 \sin\left(2 \tan^{-1}(2)\right)$$
 is

A)  $3\pi + 7$       B) 7      C)  $4\pi + 7$       D)  $3\pi - 5$

Ans. C

Sol.  $\pi - \cot^{-1} \cot(11) + 10 \sin\left(\frac{\pi}{2}\right) + 10 \sin\left(2 \tan^{-1}(2)\right)$

$$= 10 + \pi - 11 + 3\pi + 10\left(\frac{4}{1+4}\right) = 7 + 4\pi$$

### SECTION - II (ONE OR MORE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

**Full Marks** : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

**Partial Marks** : +3 If all the four options are correct but **ONLY** three options are chosen;

**Partial Marks** : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct;

**Partial Marks** : +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option;

**Zero Marks** : 0 If none of the options is chosen (i.e. the question is unanswered);

**Negative Marks** : -2 In all other cases.

For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to correct answers, then

choosing **ONLY** (A), (B) and (D) will get +4 marks; choosing **ONLY** (A) and (B) will get +2 marks; choosing **ONLY** (A) and (D) will get +2 marks;

choosing **ONLY** (B) and (D) will get +2 marks; choosing **ONLY** (A) will get +1 mark; choosing **ONLY** (B) will get +1 mark; choosing **ONLY** (D) will get +1 mark; choosing no option (i.e. the question is unanswered) will get 0 marks; and choosing any other combination of options will get -2 marks..

5. Suppose that Box I contains 6 red balls and 9 green balls, and Box II contains 8 red balls and 12 green balls. All the balls of Box I and Box II are mixed together and a ball is chosen at random from them. Let  $E_1$  be the event that the ball chosen belonged to Box I and let  $E_2$  be the event that the ball chosen belonged to Box II. Let  $F_1$  be event that the ball chosen is red and let  $F_2$  be the event that the ball chosen is green.

Then which of the following statements is (are) **TRUE**?

- A) The events  $E_1$  and  $F_1$  are independent
- B) The events  $E_2$  and  $F_2$  are dependent
- C) The conditional probability  $P(F_1 / E_1)$  is equal to the conditional probability  $P(F_1 / E_2)$
- D) The conditional probability  $P(F_1 / E_1)$  is greater than the conditional probability  $P(F_2 / E_2)$

Ans. AC

Sol.  $B - I \rightarrow 6R \quad 9G$

$B - II \rightarrow 8R \quad 12G$

$E_1 \Rightarrow \text{Box I} \quad E_2 \Rightarrow \text{Box II}$

$F_1 \Rightarrow \text{Red ball} \quad F_2 \Rightarrow \text{Green ball}$

After mixing:

$$P(E_1) = \frac{15C_1}{35C_1} = \frac{3}{7}$$

$$P(E_2) = \frac{20}{35} = \frac{4}{7}$$

$$P(F_1) = \frac{14}{35} = \frac{2}{5}$$

$$P(F_2) = \frac{21}{35} = \frac{3}{5}$$

$$A) P(E_1 \cap F_1) = \frac{6}{35}$$

$$P(E_1)P(F_1) = \frac{3}{7} \times \frac{2}{5} = \frac{6}{35}$$

$$B) P(E_2 \cap F_2) = \frac{12}{35} \Rightarrow P(E_2)P(F_2) = \frac{4}{7} \times \frac{3}{5} = \frac{12}{35}$$



$$C) P\left(\frac{F_1}{E_1}\right) = \frac{P(F_1 \cap E_1)}{P(E_1)} = P(F_1) = \frac{2}{5}$$

$$P\left(\frac{E_1}{E_2}\right) = \frac{P(F_1 \cap E_2)}{P(E_2)} = \frac{8}{35} = \frac{8}{20} = \frac{20}{35} = \frac{2}{5}$$

$$D) P\left(\frac{F_1}{E_1}\right) = \frac{2}{5} \quad P\left(\frac{F_2}{E_2}\right) = P(F_2) = \frac{3}{5}$$

6. Let  $P$  be the plane such that it contains the straight line  $\frac{x-1}{2} = \frac{y-3}{3} = \frac{z+2}{1}$  and is perpendicular to the plane  $x + 2y + 3z = 4$ . Let  $P_1$  be the plane which passes through the point  $(4, 2, 2)$  and is parallel to  $P$ .

Then which of the following statements is (are) **TRUE**?

A) The equation of the plane  $P$  is  $7x - 5y + z = -10$

B) The distance between the planes  $P$  and  $P_1$  is 30

C) The distance of the plane  $P$  from the origin is  $2\sqrt{3}$

D) The acute angle between the plane  $P$  and the plane  $2x + 2y + z = 3$  is  $\cos^{-1}\left(\frac{1}{3\sqrt{3}}\right)$

Ans. **AD**

Sol.  $P \Rightarrow \ell(x-1) + M(y-3) + n(z+2) = 0$

$$2\ell + 3m + n = 0$$

$$\ell + 2m + 3n = 0$$

$$-\frac{\ell}{7} = \frac{M}{-5} = \frac{n}{1}$$

$$7x - 5y + z + 10 = 0 \dots\dots\dots (P)$$

Equation of the plane parallel to plane P and passing through  $(4, 2, 2)$  is

$$7x - 5y + z + \lambda = 0$$

$$\Rightarrow \boxed{7x - 5y + z - 10 = 0}$$

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41

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CHANDRA DEKHAR 300/300 RANKS JEE INDIAN CENTRE 2025

V. AJAY REDDY 300/300 RANKS JEE INDIAN CENTRE 2025

REDDI ANIL 300/300 RANKS JEE INDIAN CENTRE 2024

S. VENKAT 300/300 RANKS JEE INDIAN CENTRE 2023

7. The  $\mathbb{R}$  denote that the set of all real numbers. Let  $f : \mathbb{R} \rightarrow \mathbb{R}$  be an arbitrary function and let  $g : \mathbb{R} \rightarrow \mathbb{R}$  be the function defined by

$$g(x) = xf(x), \text{ for all } x \in \mathbb{R}$$

Then which of the following statements is (are) **TRUE**?

- A) The function  $g$  is always continuous at  $x=0$   
 B) If  $f$  is continuous at  $x=0$ , then  $g$  is differentiable at  $x=0$   
 C) If  $g$  is differentiable at  $x=0$ , then  $f$  is continuous at  $x=0$   
 D) If  $g$  is differentiable at  $x=0$ , then  $\lim_{x \rightarrow 0} f(x)$  exists

Ans. **BD**

Sol. (A) if  $f(x) = \begin{cases} \frac{1}{x} & x \neq 0 \\ 0 & x = 0 \end{cases}$

Not always correct

(B)  $g(x) = \underline{x} \quad \underline{f(x)}$

Continuous and Differentiable and 0 at  $x = 0$

So, algebra of differentiability  $g(x)$  is differentiable.

(C) If  $g(x)$  is differentiable at  $x=0$ .

$$\Rightarrow g'(0) = \lim_{x \rightarrow 0} \frac{g(x) - g(0)}{x - 0}$$

$$= \lim_{x \rightarrow 0} \frac{xf(x)}{x} = \lim_{x \rightarrow 0} f(x) = \text{exist finitely. But it need not be equal to } f(0).$$

So continuity is not must.

(D) Correct explained in C option.



8. Consider the matrix

$$M = \begin{bmatrix} 2 & -1 \\ 1 & 0 \end{bmatrix}.$$

Let  $p, q, r, s, a, b, c$  and  $d$  be integers such that

$$M^{26} = \begin{bmatrix} p & q \\ r & s \end{bmatrix} \text{ and } \sum_{k=1}^{26} M^k = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

Then which of the following statements is (are) **TRUE**?

- A) There exists a  $2 \times 2$  invertible matrix  $N$  with real entries such that  $MN = N \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$
- B) The value of  $a$  is 378
- C) For any two given integers  $m$  and  $n$ , there exist unique integers  $x$  and  $y$  such that  $px + qy = m$  and  $rx + sy = n$
- D) For each positive real number  $t$ , the system of linear equations  $(a+t)x + by = 1$   
 $cx + (d+t)y = -1$  has a unique solution

Ans. **ACD**

Sol.  $M = \begin{bmatrix} 2 & -1 \\ 1 & 0 \end{bmatrix} \Rightarrow M^2 = \begin{bmatrix} 2 & -1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 2 & -1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 3 & -2 \\ 2 & -1 \end{bmatrix}$

$$\Rightarrow M^3 = \begin{bmatrix} 3 & -2 \\ 2 & -1 \end{bmatrix} \begin{bmatrix} 2 & -1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 4 & -3 \\ 3 & -2 \end{bmatrix}$$

$$\therefore M^k = \begin{bmatrix} k+1 & -k \\ k & 1-k \end{bmatrix} \quad M^{26} = \begin{bmatrix} 27 & -26 \\ 26 & -25 \end{bmatrix}$$

$$p = 27, q = -26, r = 26, s = -25$$

$$\sum_{K=1}^{26} M^K = \begin{bmatrix} a & b \\ c & d \end{bmatrix} = 13 \begin{bmatrix} 27 & -27 \\ 27 & -25 \end{bmatrix}$$



**300/300**  
P. HOHITH  
JEE ADVANCED 2025



**300/300**  
CHANDRA DEKHAR  
JEE ADVANCED 2025



**300/300**  
V. AJAY REDDY  
JEE ADVANCED 2025



**300/300**  
REDDI ANIL  
JEE ADVANCED 2024



**300/300**  
S. VENKAT  
JEE ADVANCED 2023



**HISTORY CREATED 300/300 IN JEE MAIN  
4<sup>TH</sup> YEAR IN A ROW**

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$$a = 351$$

(A) Let  $N = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$

$$MN = N \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \Rightarrow \boxed{a = c} \quad \boxed{b - d = c}$$

For invariable  $ad - bc = -a^2$  possible.

(B)  $a = 351$

(C)  $27x - 26y = M$

$$26x - 25y = N \Rightarrow 26 \times (27x - 26y) = 26M$$

$$27(26x - 25y) = 27M$$

$$(27 \times 25 - (26)^2)y = 26M - 27N$$

$$((26)^2 - 1 - (26)^2)y = 26M - 27N$$

$$\boxed{y = 27M - 26M}$$

Similarly for  $x$ . So P correct.

(D) For infinite solution

$$\frac{a+t}{c} = \frac{b}{d+t} = \frac{1}{-1}$$

$$a+t = -c \quad b = -d-t$$

$$a+c = -t \quad b+d = -t$$

$$\boxed{a+c = b+d} \text{ Not possible, system has unique solution.}$$

### SECTION-III (NUMERICAL VALUE)

This section contains **FOUR (04)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme  
Full Marks : +4 If **ONLY** the correct integer is entered; Zero Marks : 0 In all other cases.

9. Let  $S = \{1, 2, 3, \dots, 10\}$ . Consider the set

$X = \{R : R \text{ is an equivalent relation on the set } S \text{ such that } R \text{ has exactly 42 elements}\}$ .

Then the number of elements in  $X$  is \_\_\_\_\_.

Ans. **2520**



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**300/300**  
CHANDRA DEKHAR  
JEE ADVANCED 2025



**300/300**  
V. AJAY REDDY  
JEE ADVANCED 2025



**300/300**  
REDDI ANIL  
JEE ADVANCED 2024



**300/300**  
S. VENKAT  
JEE ADVANCED 2023



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**Sol.** The number of ways to partition a set of 10 elements into sizes of

$$(1) 5, 4, 1 \text{ in } \frac{|10|}{|5|4} = 1260$$

$$(2) 6, 2, 1, 1 \text{ in } \frac{|10|}{|6|2|1|1|2} = 1260 \quad \therefore n(X) = 2520$$

**10.** Consider the function  $f : \left(-\frac{\pi}{2}, \frac{\pi}{2}\right) \rightarrow (-\infty, \infty)$  defined by

$$f(x) = (|x| + |x-1|)\sin x + [x \sin x],$$

where  $[x \sin x]$  is the greatest integer less than or equal to  $x \sin x$ .

Let  $\alpha$  be the total number of points in the interval  $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$  at which  $f$  is **NOT**

continuous, and let  $\beta$  be the total number of points in the interval  $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$  at which  $f$  is

**NOT** differentiable.

Then the value  $\alpha + \beta$  of is \_\_\_\_\_.

**Ans. 5**

$$\text{Sol. } f(x) = (|x| + |x-1|)\sin x + [x \sin x] = \begin{cases} (1-2x)\sin x + [x \sin x], & x < 0 \\ \sin x + [x \sin x], & 0 \leq x \leq 1 \\ (2x-1)\sin x + [x \sin x], & x > 1 \end{cases}$$

Let  $g(x) = x \sin x \Rightarrow g(x)$  is an even function and  $g(x) > 0 \forall x > 0$  and  $x < 0$  and

$$g(0) = 0 \quad \therefore [g(x)] = \begin{cases} 1, & -\frac{\pi}{2} < x \leq -\alpha \\ 0, & -\alpha < x < \alpha, \alpha \in \left(0, \frac{\pi}{2}\right) \\ 1, & \alpha \leq x < \frac{\pi}{2} \end{cases}$$

$\therefore f(x)$  is discontinuous at 2 points and  $f(x)$  is not differentiable at  $x = 1$  but, it is

continuous at  $x = 1$ .

$\therefore f(x)$  is not differentiable at 3 points.

$$\therefore \alpha = 2, \beta = 3 \Rightarrow \alpha + \beta = 5$$



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11. The number of ways to distribute 10 identical red pens and 14 identical blue pens among four persons such that each person gets 6 pens, is \_\_\_\_\_.

Ans. 206

Sol. Let  $x_1, x_2, x_3, x_4$  are 4 persons.

$$\therefore x_1 + x_2 + x_3 + x_4 = 24 \text{ and } x_1 = x_2 = x_3 = x_4 = 6.$$

Req. Number of ways is equal to total number of solutions of  $x_1 + x_2 + x_3 + x_4 = 10$  and  $x_1, x_2, x_3, x_4 \in \{0, 1, 2, 3, \dots, 6\}$

Total no. of ways = Coefficient of  $x^{10}$  in  $(1 + x + \dots + x^6)^4$

$$\begin{aligned} &= \text{Coefficient of } x^{10} \text{ in } \left( \frac{1-x^7}{1-x} \right)^4 = 11 \left( \frac{1-x^7}{1-x} \right)^4 \\ &= {}^{13}C_{10} - {}^4C_1 \times {}^6C_3 = 286 - 80 = 206 \end{aligned}$$

12. Let

$$\alpha = \left( 1 - 2\cos\left(\frac{\pi}{11}\right) \right) \left( 1 - 2\cos\left(\frac{3\pi}{11}\right) \right) \left( 1 - 2\cos\left(\frac{9\pi}{11}\right) \right) \left( 1 - 2\cos\left(\frac{27\pi}{11}\right) \right) \left( 1 - 2\cos\left(\frac{81\pi}{11}\right) \right).$$

Then the value of  $5 - \alpha^2$  is \_\_\_\_\_.

Ans. 4

Sol.  $1 - 2\cos\theta = 1 - 2\left(2\cos^2\left(\frac{\theta}{2}\right) - 1\right) = 3 - 4\cos^2\left(\frac{\theta}{2}\right) = \frac{-\cos\left(\frac{3\theta}{2}\right)}{\cos\frac{\theta}{2}}$

$$\begin{aligned} \therefore \alpha &= - \frac{\cos\left(\frac{3\pi}{22}\right)}{\cos\left(\frac{\pi}{22}\right)} \times \frac{\cos\left(\frac{9\pi}{22}\right)}{\cos\left(\frac{3\pi}{22}\right)} \times \frac{\cos\left(\frac{27\pi}{22}\right)}{\cos\left(\frac{9\pi}{22}\right)} \times \frac{\cos\left(\frac{81\pi}{22}\right)}{\cos\left(\frac{27\pi}{22}\right)} \times \frac{\cos\left(\frac{243\pi}{22}\right)}{\cos\left(\frac{81\pi}{22}\right)} \\ &= - \frac{\cos\left(\frac{243\pi}{22}\right)}{\cos\left(\frac{\pi}{22}\right)} = -1 \end{aligned} \quad \therefore 5 - \alpha^2 = 4$$









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## SECTION – IV (MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists: **List-I** and **List-II**.
- **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme:

**Full Marks:** +4 **ONLY** if the option corresponding to the correct combination is chosen;

**Zero Marks:** 0 If none of the options is chosen (i.e. the question is unanswered);

**Negative Marks:** -1 In all other cases

**13.** Match each entry in List-I to the correct entry in List-II and choose the correct option.

**List-I**

**List-II**

(P) If  $\alpha$  and  $\beta$  are the distinct roots of the

(1)  $x^2 + x + 1 = 0$

Equation  $x^2 + x + 1 = 0$ , then the  
Quadratic equation with roots

$$\frac{1}{(\alpha+1)^{2026}} \text{ and } \frac{1}{(\beta+1)^{2026}} \text{ is}$$

(Q) If  $\alpha$  and  $\beta$  are the distinct roots of the

(2)  $x^2 - x + 1 = 0$

Equation  $x^2 + x + 1 = 0$ , then the  
quadratic equation with roots

$$\frac{1}{(\alpha+1)^{2027}} \text{ and } \frac{1}{(\beta+1)^{2027}} \text{ is}$$

(R) If  $\gamma$  and  $\delta$  are the distinct roots of the

(3)  $x^2 + x - 1 = 0$

equation  $x^2 - x + 1 = 0$ , then the value

$$\text{of } \frac{1}{(\gamma-1)^{2026}} + \frac{1}{(\delta-1)^{2026}} \text{ is}$$

(S) If  $p$  and  $r$  are the distinct roots of the

(4) -1

equation  $x^2 + x - 1 = 0$ , then the value

$$\text{of } \frac{1}{(p+1)^3} + \frac{1}{(r+1)^3} \text{ is}$$

(5) -4



- A)  $(P) \rightarrow (1), (Q) \rightarrow (2), (R) \rightarrow (5), (S) \rightarrow (4)$
- B)  $(P) \rightarrow (3), (Q) \rightarrow (1), (R) \rightarrow (4), (S) \rightarrow (5)$
- C)  $(P) \rightarrow (1), (Q) \rightarrow (2), (R) \rightarrow (4), (S) \rightarrow (5)$
- D)  $(P) \rightarrow (2), (Q) \rightarrow (3), (R) \rightarrow (5), (S) \rightarrow (4)$

Ans. C

Sol.  $\alpha, \beta$  are distinct roots of  $x^2 + x + 1 = 0$

$$\Rightarrow \alpha, \beta = \omega, \omega^2$$

If  $\alpha = \omega, \beta = \omega^2$

$$\therefore \frac{1}{(\alpha + 1)^{2026}} = \frac{1}{(-\omega^2)^{2026}} = \frac{1}{\omega^2} = \omega$$

$$\frac{1}{(\beta + 1)^{2026}} = \frac{1}{(-\omega^2)^{2026}} = \frac{1}{\omega} = \omega^2$$

The equation whose roots of  $(\alpha + 1)^{-2026}, (\beta + 1)^{-2026}$  is  $x^2 + x + 1 = 0$

$$\text{If } \alpha = \omega, \beta = \omega^2 \Rightarrow \frac{1}{(\alpha + 1)^{2027}} = \frac{1}{(-\omega^2)^{2027}} = \frac{-1}{\omega} = -\omega^2 \text{ and}$$

$$\frac{1}{(\beta + 1)^{2027}} = \frac{1}{(-\omega)^{2027}} = \frac{-1}{\omega^2} = -\omega$$

The equation whose roots are  $(\alpha + 1)^{-2027}, (\beta + 1)^{-2027}$  is  $x^2 - x + 1 = 0$   $\gamma, \delta$  are

distinct roots of  $x^2 - x + 1 = 0 \Rightarrow \gamma, \delta = -\omega, -\omega^2$

$$\text{If } \gamma = -\omega, \delta = -\omega^2 \Rightarrow \frac{1}{(\gamma - 1)^{2026}} = \frac{1}{(\omega^2)^{2026}} = \omega \text{ and } \frac{1}{(\delta - 1)^{2026}} = \frac{1}{(\omega)^{2026}} = \omega^2$$

The equation whose roots are  $\frac{1}{(\gamma - 1)^{2026}}, \frac{1}{(\delta - 1)^{2026}}$  is  $x^2 + x + 1 = 0$  and









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$$\frac{1}{(\gamma-1)^{2026}} + \frac{1}{(\delta-1)^{2026}} = -1$$

If  $p, r$  are distinct roots of  $x^2 + x - 1 = 0$

$$\therefore p + r = -1, pr = -1$$

$$p + 1 = -r, r + 1 = -p$$

$$\therefore \frac{1}{(p+1)^3} + \frac{1}{(r+1)^3} = \frac{-1}{r^3} - \frac{1}{p^3}$$

$$= \frac{-(p^3 + r^3)}{(pr)^3} = \frac{-(p+r)((p+r)^2 - 3pr)}{(pr)^3} = -4$$

14. Match each entry in List-I to the correct entry in List-II and choose the correct option.

**List-I**

(P) The number of elements in the set

(Q) The number of elements in the set

(R) The number of elements in the set

(S) The number of elements in the set

**List-II**

(1) is  $\{x \in [-\pi, \pi] : \sin^6 x + \cos^4 x = 1\}$

(2) is  $\{x \in [-\frac{\pi}{2}, \frac{\pi}{2}] : \sin^2 x + \cos^6 x = 1\}$

(3) is  $\{x \in [-\pi, \pi] : \cos^2(\frac{x}{2}) - \sin^2 x = \frac{1}{2}\}$

(4) is  $\{x \in [-2\pi, 2\pi] : 6\sin^2(\frac{x}{2}) - \cos 3x = 3\}$

(5) is 5

A) (P) → (2), (Q) → (5), (R) → (3), (S) → (4)

B) (P) → (5), (Q) → (3), (R) → (2), (S) → (4)

C) (P) → (5), (Q) → (4), (R) → (1), (S) → (3)

D) (P) → (4), (Q) → (3), (R) → (2), (S) → (5)

Ans. B



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**Sol.** (P)  $\sin^6 x + \cos^4 x = 1$

$$\Rightarrow \sin^6 x = 1 - \cos^4 x = \sin^2 x (1 + \cos^2 x)$$

$$\Rightarrow \sin^2 x = 0 \text{ (or) } \sin^4 x = 2 - \sin^2 x$$

$$\sin^2 x = 0 \text{ (or) } \sin^2 x = 1 \Rightarrow x = 0, \pi, -\pi, \frac{\pi}{2}, \frac{-\pi}{2} (\because x \in [-\pi, \pi])$$

(Q)  $\cos^6 x + \sin^2 x = 1 \Rightarrow \cos^6 x = \cos^2 x$

$$\cos^2 x = 0 \text{ (or) } \cos^2 x = 1 \Rightarrow x = \pm \frac{\pi}{2}, x = 0 (\because x \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right])$$

(R)  $\cos^2\left(\frac{x}{2}\right) - \sin^2 x = \frac{1}{2} \Rightarrow \frac{2\cos^2\left(\frac{x}{2}\right) - 1}{2} = \sin^2 x$

$$\Rightarrow \cos x = 2(1 - \cos^2 x) \Rightarrow 2\cos^2 x + \cos x - 2 = 0$$

$$\Rightarrow \cos x = \frac{-1 \pm \sqrt{1+16}}{4} = \frac{\sqrt{17}-1}{4}$$

$\therefore$  The number of values of  $x$  satisfying above equations, when  $x \in [-\pi, \pi]$  is 2.

(S)  $6\sin^2\left(\frac{x}{2}\right) - \cos 3x = 3 \Rightarrow \cos 3x + 3\cos x = 0$

$$\Rightarrow 4\cos^3 x = 0 \Rightarrow \cos x = 0 \Rightarrow x = \pm \frac{\pi}{2}, \pm \frac{3\pi}{2} (\because x \in [-2\pi, 2\pi])$$

15. For real numbers  $\alpha, \beta, \gamma, \delta$  and  $\mu$ , consider the matrix

$$M = \begin{bmatrix} \alpha & \frac{1}{\sqrt{2}} & -\frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{3}} & \beta & \frac{1}{\sqrt{3}} \\ \gamma & \delta & \mu \end{bmatrix}$$

Suppose that  $MM^T = I$ , where  $M^T$  is the transpose of the matrix  $M$ , and  $I$  is the  $3 \times 3$  identity matrix. Let

$$\vec{u} = \alpha \hat{i} + \frac{1}{\sqrt{3}} \hat{j} + \gamma \hat{k}, \quad \vec{v} = \frac{1}{\sqrt{2}} \hat{i} + \beta \hat{j} + \delta \hat{k} \text{ and } \vec{w} = -\frac{1}{\sqrt{2}} \hat{i} + \frac{1}{\sqrt{3}} \hat{j} + \mu \hat{k}$$



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Match each entry in List-I to the correct entry in List-II and choose the correct option.

**List-I**

- (P) The value of  $\gamma^2 + \delta^2$  is
- (Q) If  $x\vec{u} + y\vec{v} + z\vec{w} = \hat{j}$  for some real numbers  $x, y$  and  $z$ , then the value of  $x$  is

(R) The value of  $\left| \vec{u} \cdot (\vec{v} \times \vec{w}) \right|$  is

(S) The value of  $\left| \vec{u} \times (\vec{v} \times \vec{w}) \right|$  is

**List-II**

- (1) 0
- (2) 1
- (3)  $\frac{1}{\sqrt{2}}$
- (4)  $\frac{1}{\sqrt{3}}$
- (5)  $\frac{5}{6}$

- A) (P)  $\rightarrow$  (5), (Q)  $\rightarrow$  (4), (R)  $\rightarrow$  (2), (S)  $\rightarrow$  (1)
- B) (P)  $\rightarrow$  (4), (Q)  $\rightarrow$  (5), (R)  $\rightarrow$  (1), (S)  $\rightarrow$  (2)
- C) (P)  $\rightarrow$  (5), (Q)  $\rightarrow$  (3), (R)  $\rightarrow$  (2), (S)  $\rightarrow$  (1)
- D) (P)  $\rightarrow$  (5), (Q)  $\rightarrow$  (4), (R)  $\rightarrow$  (1), (S)  $\rightarrow$  (2)

**Ans. A**

**Sol.**  $M = \begin{bmatrix} \alpha & \frac{1}{\sqrt{2}} & \frac{-1}{\sqrt{2}} \\ \frac{1}{\sqrt{3}} & \beta & \frac{1}{\sqrt{3}} \\ \gamma & \delta & \mu \end{bmatrix}$  and  $MM^T = I \Rightarrow \alpha^2 + \frac{1}{2} + \frac{1}{2} = 1 \Rightarrow \alpha = 0,$

$\frac{1}{3} + \beta^2 + \frac{1}{3} = 1 \Rightarrow \beta^2 = \frac{1}{3}, \gamma^2 + \delta^2 + \mu^2 = 1,$

$\frac{\alpha}{\sqrt{3}} + \frac{\beta}{\sqrt{2}} - \frac{1}{\sqrt{6}} = 0$  and  $\alpha = 0 \Rightarrow \beta = \frac{1}{\sqrt{3}}$

$\alpha\gamma + \frac{\delta}{\sqrt{2}} - \frac{\mu}{\sqrt{2}} = 0 \Rightarrow \delta = \mu$









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$$\frac{\gamma}{\sqrt{3}} + \beta\delta + \frac{\mu}{\sqrt{3}} = 0$$

$$\Rightarrow \gamma + \delta + \mu = 0 \Rightarrow \gamma = -2\mu$$

$$\therefore 4\mu^2 + \mu^2 + \mu^2 = 1 \quad \Rightarrow \mu^2 = \frac{1}{6}$$

$$(P) \gamma^2 + \delta^2 = 5\mu^2 = \frac{5}{6}$$

$$(Q) \text{ If } x\bar{u} + y\bar{v} + z\bar{w} = \hat{j}$$

$$\Rightarrow \frac{y}{\sqrt{2}} - \frac{z}{\sqrt{2}} = 0 \Rightarrow y = z, \frac{x}{\sqrt{3}} + \frac{y}{\sqrt{3}} + \frac{z}{\sqrt{3}} = 1$$

$$\Rightarrow x + y + z = \sqrt{3} \text{ and } \gamma x + \delta y + \mu z = 0$$

$$\Rightarrow -2x + y + z = 0 \Rightarrow x = \frac{1}{\sqrt{3}}$$

$$(R) \left| \vec{u} \cdot (\vec{v} \times \vec{w}) \right| = \begin{vmatrix} 0 & \frac{1}{\sqrt{3}} & -2\mu \\ \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{3}} & \mu \\ -1 & \frac{1}{\sqrt{3}} & \mu \end{vmatrix}$$

$$= 10 - \frac{1}{\sqrt{3}} \left( \frac{\mu}{\sqrt{2}} + \frac{\mu}{\sqrt{2}} \right) - 2\mu \left( \frac{1}{\sqrt{6}} + \frac{1}{\sqrt{6}} \right)$$

$$= \left| -\frac{2\mu}{\sqrt{6}} - \frac{4\mu}{\sqrt{6}} \right| = \left| -\sqrt{6}\mu \right| = 1$$

$$(S) \left| \bar{u} \times (\bar{v} \times \bar{w}) \right| = \left| (\bar{u} \cdot \bar{w})\bar{v} - (\bar{u} \cdot \bar{v})\bar{w} \right|$$

$$= 0$$

16. Match each entry in List-I to the correct entry in List-II and choose the correct option.

**List-I**

(P) The circle with centre (1, 2) and touching the straight line  $3x + 4y = 1$ , passes through

(Q) The common tangent to the circle  $x^2 + y^2 = 2$  and the parabola  $y^2 = 8x$  with positive slope, passes through

(R) Let  $M$  be the end point of the latus rectum of the ellipse  $3x^2 + 4y^2 = 48$  such that  $M$  lies in the first quadrant. Then the normal to the ellipse drawn at  $M$  Passes through

(S) Let  $H$  be the hyperbola whose centre is at the origin, one of the foci is at (5, 0), and one directrix is  $5x + 16 = 0$ . Then  $H$  passes through

**List-II**

(1) the point (1, 1)

(2) the point (7, 9)

(3) the point (3, 2)

(4) the point (2, 5)

(5) the point  $(8, 3\sqrt{3})$

A) (P)  $\rightarrow$  (3), (Q)  $\rightarrow$  (4), (R)  $\rightarrow$  (1), (S)  $\rightarrow$  (2)

B) (P)  $\rightarrow$  (3), (Q)  $\rightarrow$  (2), (R)  $\rightarrow$  (1), (S)  $\rightarrow$  (5)

C) (P)  $\rightarrow$  (3), (Q)  $\rightarrow$  (2), (R)  $\rightarrow$  (4), (S)  $\rightarrow$  (5)

D) (P)  $\rightarrow$  (4), (Q)  $\rightarrow$  (1), (R)  $\rightarrow$  (2), (S)  $\rightarrow$  (3)

**Ans. B**

**Sol.** (P)  $(x-1)^2 + (y-2)^2 = r^2$

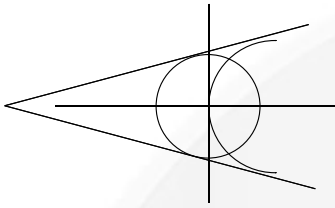
$$\left| \frac{3+8-1}{5} \right| = r$$



$$r = 2$$

$$(r-1)^2 + (y-2)^2 = 4$$

$$(Q) \ y = Mx + \frac{2}{M} \Rightarrow Mx - y + \frac{2}{M} = 0$$



$$\frac{\frac{2}{M}}{\sqrt{1+M^2}} = \sqrt{2}$$

$$\sqrt{2} = M\sqrt{1+M^2}$$

$$\boxed{y = x + 2}$$

$$2 = M^2(1+M^2)$$

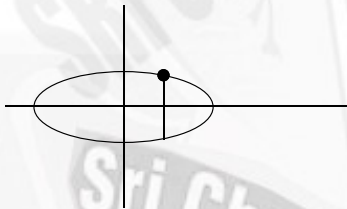
$$\boxed{y = -x - 2}$$

$$M^4 + M^2 - 2 = 0$$

$$\boxed{M^2 = 1}$$

$$\boxed{M = \pm 1} \Rightarrow M = 1 (\because M > 0)$$

$$(R) \ \frac{x^2}{16} + \frac{y^2}{12} = 1$$



$$12 = 16(1 - e^2)$$

$$1 - e^2 = \frac{3}{4}$$

$$e^2 = \frac{1}{4}$$

$$\boxed{e = \frac{1}{2}}$$

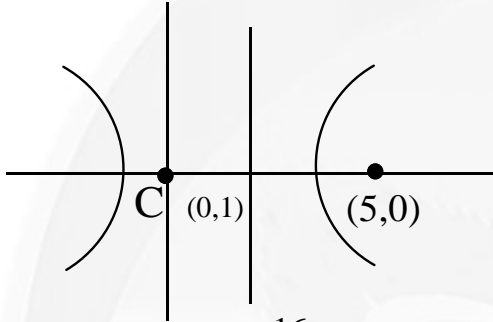
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$$L\left(4 \times \frac{1}{2}, \frac{12}{4}\right)$$

$L(2,3) \Rightarrow$  Equation of normal at L to the ellipse is  $2x - y = 1$ .

$$(S) \frac{x^2}{16} - \frac{y^2}{9} = 1$$



$$ae = 5 \quad x = \frac{-16}{5} \quad a^2 = 16$$

$$\frac{a}{e} = \frac{16}{5} \quad \frac{a}{e} = \frac{16}{5} \quad \boxed{a = 4}$$

$$ae = 5 \quad \boxed{e = \frac{5}{4}}$$

$$b^2 = a^2 \left( \frac{25}{16} - 1 \right)$$

$$= 16 \times \frac{9}{16} = \boxed{b^2 = 9}$$

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## PHYSICS

Max Marks: 60

SECTION – I  
(SINGLE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

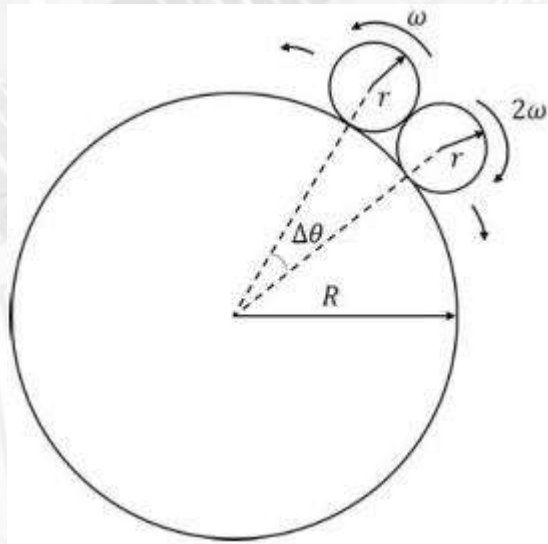
**Full Marks** : +3 If **ONLY** the correct option is chosen;

**Zero Marks** : 0 If none of the options is chosen (i.e. the question is unanswered);

**Negative Marks** : -1 In all other cases

17. Consider a large disk of radius  $R$  and two smaller disks, each of radius  $r = R/50$ , lying on its circumference, as shown in the figure. The smaller disks are initially in contact with each other, with an angular separation  $\Delta\theta$  between their centers. They are made to roll without slipping in opposite directions, with constant angular velocities  $\omega$  and  $2\omega$  while the large disk is held stationary. The time  $\tau$  at which the smaller disks are again in contact is:

[Use  $\sin(\Delta\theta) = \Delta\theta$  and ignore gravity.]



- A)  $\tau = 51 \times \left(2\pi - \frac{4}{51}\right) / \omega$       B)  $\tau = 51 \times \left(2\pi - \frac{2}{51}\right) / 3\omega$   
 C)  $\tau = 51 \times \left(2\pi - \frac{4}{51}\right) / 3\omega$       D)  $\tau = 51 \times \left(2\pi - \frac{2}{51}\right) / \omega$

ANS : C

SOL :



Two small disks rolling on a large fixed disk

### Geometry

Each small disk has radius  $r = R/50$ , so the centres lie on a circle of radius

$R + r = 51R/50$ . For the small disks to be tangent, the chord between centres equals  $2r$ :

$$2(R+r)\sin(\Delta\theta/2) = 2r \Rightarrow \Delta\theta \approx \frac{2r}{R+r} = \frac{2}{51}.$$

### Angular speed of each centre about the big disk

For external rolling without slipping on a fixed surface,  $v = r\omega$ , so the angular speed of

each centre is  $\Omega = \frac{v}{R+r} = \frac{r\omega}{R+r} = \frac{\omega}{51}$ .

The two centres move in opposite directions, hence  $\Omega_{rel} = \frac{\omega}{51} + \frac{2\omega}{51} = \frac{3\omega}{51}$ .

### Angle swept by the relative coordinate

Starting tangent (gap  $+\Delta\theta$ ), the disks separate. They are tangent again only when the gap reaches  $(2\pi - \Delta\theta)$ , i.e.  $\Delta\theta$  on the other side. Therefore the relative coordinate sweeps

$$\Delta\phi = (2\pi - \Delta\theta) - \Delta\theta = 2\pi - 2\Delta\theta = 2\pi - \frac{4}{51}.$$

*Common error:* writing  $2\pi - \Delta\theta$  only excludes the initial gap; that would correspond to the two centres coinciding, which is geometrically impossible. Both starting and final tangent positions must be excluded.

### Time

$$\tau = \frac{\Delta\phi}{\Omega_{rel}} = \frac{2\pi - 4/51}{3\omega/51} = \frac{51(2\pi - 4/51)}{3\omega}.$$

Answer: (C)  $\tau = \frac{51(2\pi - 4/51)}{3\omega}$





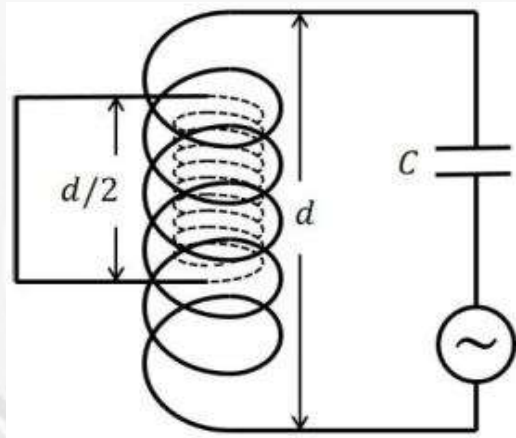



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18. Consider a circuit consisting of a capacitor of capacitance  $C$  and a coil with  $N$  turns per unit length, cross sectional area  $S$  and length  $d$ , where  $d^2 \gg S$ . There is another coil of length  $d/2$ , cross sectional area  $S/2$  and  $2N$  turns per unit length completely inside the larger coil, as shown in the figure. The ends of this smaller coil are connected with each other by an insulated conducting wire. The self-inductance of the larger coil is  $L$ . Neglecting edge effects and all the Ohmic resistances, the resonant frequency of the circuit is:



- A)  $\frac{4}{\sqrt{15LC}}$       B)  $\frac{6}{\sqrt{5LC}}$       C)  $\frac{2}{\sqrt{3LC}}$       D)  $\sqrt{\frac{2}{3LC}}$

ANS : C

SOL :

**LC circuit coupled to a shorted inner solenoid**

**Self-inductances**

Large coil:  $L = \mu_0 N^2 S d$ . Inner coil with  $2N$  turns/length, area  $S/2$ , length  $d/2$ :

$$L_2 = \mu_0 (2N)^2 (S/2) (d/2) = \mu_0 N^2 S d = L.$$

**Mutual inductance**

Inside the large coil,  $B = \mu_0 N I_1$ . The inner coil has  $Nd$  total turns linking flux through area  $S/2$ :



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$$\Phi_2 = (Nd)(\mu_0 NI_1)(S/2) = \frac{1}{2} \mu_0 N^2 Sd I_1 \Rightarrow M = \frac{L}{2}$$

**Effective inductance with the inner coil shorted**

With  $V_2 = 0$ , the coupled equations give  $\dot{I}_2 = -(M/L_2)\dot{I}_1$ , so

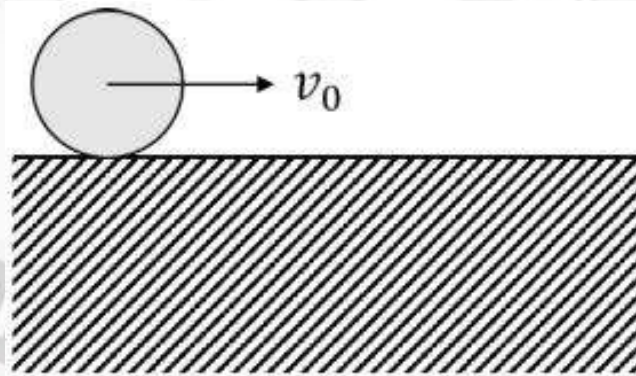
$$V_1 = \left( L - \frac{M^2}{L_2} \right) \dot{I}_1 \Rightarrow L_{eff} = L - \frac{(L/2)^2}{L} = \frac{3L}{4}$$

**Resonant frequency**

$$\omega_r = \frac{1}{\sqrt{L_{eff} C}} = \frac{1}{\sqrt{3LC/4}} = \frac{2}{\sqrt{3LC}}$$

Answer: (C)  $\omega_r = \frac{2}{\sqrt{3LC}}$

19. A solid cylinder of radius  $R$  rolls without slipping with a center of mass speed  $v_0 = \sqrt{\frac{gR}{3}}$  on a horizontal surface with a vertical edge, as shown in the figure. Here,  $g$  is the acceleration due to the gravity. At the moment when the cylinder loses contact with the surface due to rotation around the corner, the speed of its center of mass is:



- A) 0                      B)  $\sqrt{\frac{5gR}{7}}$                       C)  $\sqrt{\frac{gR}{15}}$                       D)  $\sqrt{\frac{3gR}{7}}$

ANS : B

SOL :

Cylinder rolling off a vertical edge



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**Moment of inertia about the corner**

$$I_O = I_{cm} + mR^2 = \frac{1}{2}mR^2 + mR^2 = \frac{3}{2}mR^2.$$

**Initial KE about the corner**

At the instant the contact point reaches the corner, angular momentum about the corner is conserved during the transition, giving  $\omega' = v_0 / R$ . With  $v_0^2 = gR / 3$ ,

$$KE_0 = \frac{1}{2} \left( \frac{3}{2}mR^2 \right) (v_0 / R)^2 = \frac{3}{4}mv_0^2 = \frac{mgR}{4}.$$

**Energy conservation through angle  $\varphi$  from vertical**

$$\frac{3}{4}mv^2 + mgR \cos \varphi = \frac{mgR}{4} + mgR \Rightarrow v^2 = v_0^2 + \frac{4}{3}gR(1 - \cos \varphi).$$

**Loss of contact:  $N = 0$** 

Radial equation:  $mg \cos \varphi - N = mv^2 / R$ . Setting  $N = 0$ :

$$v^2 = gR \cos \varphi.$$

Combining with the energy equation,

$$gR \cos \varphi = \frac{gR}{3} + \frac{4}{3}gR(1 - \cos \varphi) \Rightarrow \cos \varphi = \frac{5}{7},$$

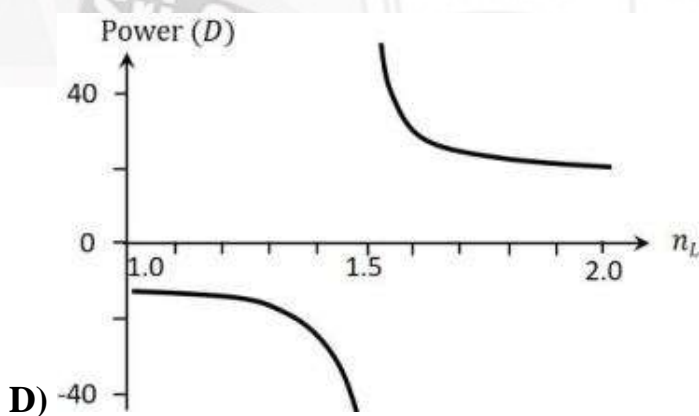
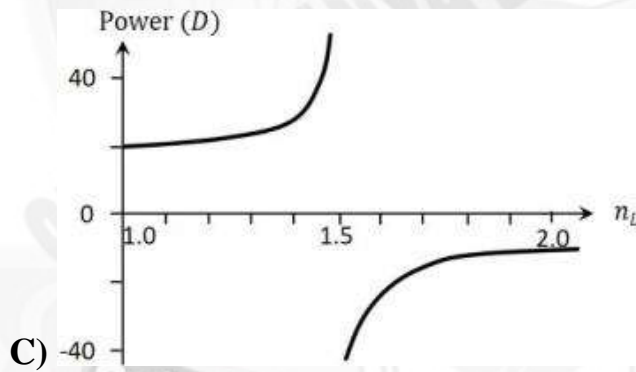
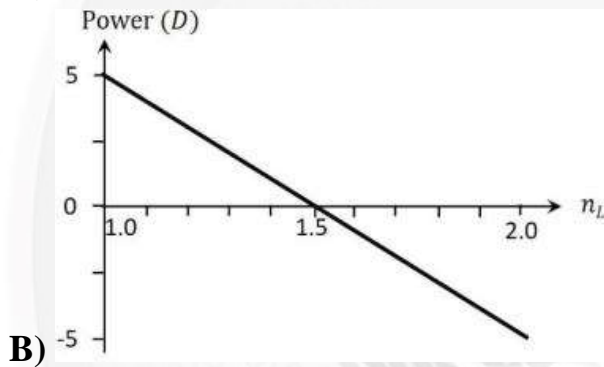
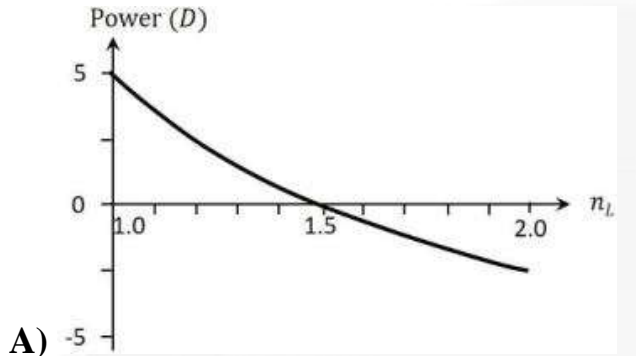
Hence

$$v^2 = gR \cdot \frac{5}{7} = \frac{5gR}{7} \Rightarrow v = \sqrt{\frac{5gR}{7}}$$

Answer: (B)  $v = \sqrt{5gR / 7}$



20. A double convex lens made of glass of refractive index 1.5 and radii of curvature of the curved surfaces 20 cm each is immersed in a liquid of refractive index  $n_L$ . The correct plot showing the variation of the power, in the units of diopter ( $D$ ), as a function of  $n_L$  is:



ANS : A (AS PER NCERT) OR B



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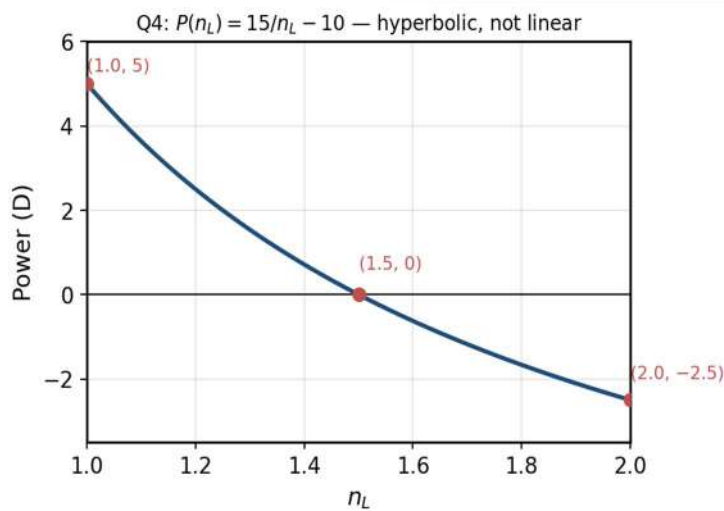


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SOL :

**Power of a double-convex lens immersed in liquid****NCERT SOLUTION****Lensmaker's formula**

With  $R_1 = +0.20m$  and  $R_2 = -0.20m$  so that  $1/R_1 - 1/R_2 = 10m^{-1}$ ,

$$P(n_L) = \left( \frac{n_g}{n_L} - 1 \right) \left( \frac{1}{R_1} - \frac{1}{R_2} \right) = 10 \left( \frac{1.5}{n_L} - 1 \right) = \frac{15}{n_L} - 10.$$

**Sample values**

- $n_L = 1.0 \Rightarrow P = +5D$
- $n_L = 1.5 \Rightarrow P = 0$  (lens optically vanishes)
- $n_L = 2.0 \Rightarrow P = -2.5D$
- $n_L = \infty \Rightarrow P = -10D$  (horizontal asymptote)

The curve is a decreasing hyperbola, not a straight line.

Answer: (A) Hyperbolic decay through  $(1, 5), (1.5, 0), (2, -2.5)$

**CORRECT SOLUTION**

## 1. Power in a Medium:

The power of a lens immersed in a liquid medium of refractive index  $n_L$  is defined as:

$$P = \frac{n_L}{f} = n_L \left( \frac{n_g}{n_L} - 1 \right) \left( \frac{1}{R_1} - \frac{1}{R_2} \right)$$



2. Substituting the Parameters:

Given  $n_g = 1.5$ ,  $R_1 = +0.2m$ , and  $R_2 = -0.2m$  :

$$\left( \frac{1}{R_1} - \frac{1}{R_2} \right) = \frac{1}{0.2} - \left( -\frac{1}{0.2} \right) = 10m^{-1}$$

$$P = (n_g - n_L) \times 10 = 10(1.5 - n_L)$$

3. Key Data Points:

- At  $n_L = 1.0$ :  $P = 10(1.5 - 1.0) = +5D$
- At  $n_L = 1.5$ :  $P = 10(1.5 - 1.5) = 0D$
- At  $n_L = 2.0$ :  $P = 10(1.5 - 2.0) = -5D$

Since  $P$  is a linear function of  $n_L$  with a negative slope, the graph is a straight line matching plot (A).

Correct Option: (A)

## SECTION – II (ONE OR MORE CORRECT ANSWER TYPE)

This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme:

**Full Marks** : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

**Partial Marks** : +3 If all the four options are correct but **ONLY** three options are chosen;

**Partial Marks** : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct;

**Partial Marks** : +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option;

**Zero Marks** : 0 If none of the options is chosen (i.e. the question is unanswered);

**Negative Marks** : -2 In all other cases.

For example, in a question, if (A), (B) and (D) are the **ONLY** three options corresponding to correct answers, then choosing **ONLY** (A), (B) and (D) will get +4 marks; choosing **ONLY** (A) and (B) will get +2 marks; choosing **ONLY** (A) and (D) will get +2 marks; choosing **ONLY** (B) and (D) will get +2 marks; choosing **ONLY** (A) will get +1 mark; choosing **ONLY** (B) will get +1 mark; choosing **ONLY** (D) will get +1 mark; choosing no option (i.e. the question is unanswered) will get 0 marks; and choosing any other combination of options will get -2 marks.

21. Consider a hydrogen atom with  $v_k$ ,  $r_k$  and  $K_k$  denoting the velocity, orbital radius and kinetic energy of the electron in the  $k^{\text{th}}$  orbit, respectively. The electron undergoes a transition from the  $n^{\text{th}}$  orbit, emitting radiation corresponding to the Lyman series. Considering  $h$  to be the Planck's constant and  $\epsilon_0$  the permittivity of the free space, the correct statement(s) is/are:

A) Magnitude of change in kinetic energy of electron can be expressed as  $\frac{h}{4\pi} \left| \frac{nv_n}{r_n} - \frac{v_1}{r_1} \right|$ .

B) Magnitude of change in de Broglie wavelength of the electron can be expressed as

$$\frac{e^2}{4\epsilon_0} \left| \frac{1}{K_n} - \frac{1}{K_1} \right|.$$

C) Frequency of the radiation emitted can be expressed as  $\frac{e^2}{8\pi\epsilon_0 h} \left( \frac{1}{r_1} - \frac{1}{r_n} \right)$ .

D) Magnitude of change in total energy of the electron can be expressed as  $\frac{h}{2\pi} \left| \frac{v_1}{r_1} - \frac{nv_n}{r_n} \right|$ .

ANS : AC

SOL :

Lyman-series transition in hydrogen

**Bohr relations**

$$mv_k r_k = \frac{kh}{2\pi} \Rightarrow mv_k = \frac{kh}{2\pi r_k}.$$

$$K_k = \frac{1}{2} mv_k^2 = \frac{1}{2} v_k (mv_k) = \frac{kh}{4\pi} \frac{v_k}{r_k}.$$

For a Coulomb orbit,  $K_k = \frac{e^2}{8\pi\epsilon_0 r_k}$  and  $E_k = -K_k$ .

**(A) Change in kinetic energy**

$$|\Delta K| = K_1 - K_n = \frac{h}{4\pi} \left| \frac{v_1}{r_1} - \frac{nv_n}{r_n} \right|.$$

**(B) Change in de Broglie wavelength**

From  $n\lambda_k = 2\pi r_k$  and  $r_k = e^2 / (8\pi\epsilon_0 K_k)$ ,

$$\lambda_k = \frac{2\pi r_k}{k} = \frac{e^2}{4k\epsilon_0 K_k}, \quad |\Delta\lambda| = \frac{e^2}{4\epsilon_0} \left| \frac{1}{nK_n} - \frac{1}{K_1} \right|.$$

Option (B) drops the factor  $1/n$  inside the modulus. **FALSE.**

**(C) Frequency of emitted radiation**

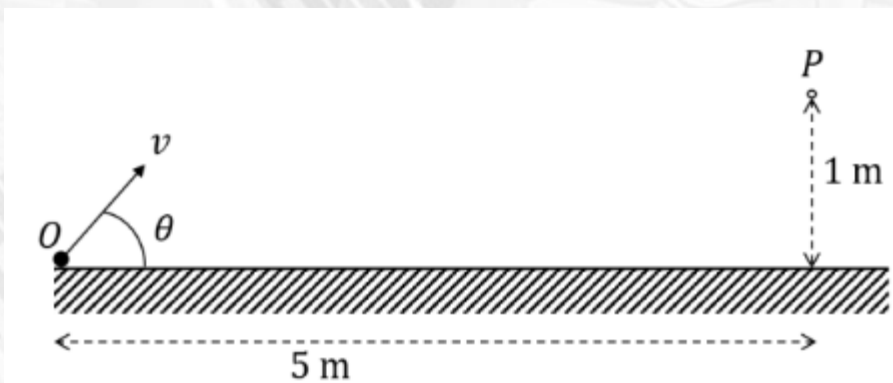
$$hf = E_n - E_1 = K_1 - K_n = \frac{e^2}{8\pi\epsilon_0} \left( \frac{1}{r_1} - \frac{1}{r_n} \right).$$

**(D) Total-energy change**

$|\Delta E| = |\Delta K|$  carries the prefactor  $h/(4\pi)$ , but option (D) uses  $h/(2\pi)$ — wrong by a factor of 2. **FALSE.**

Answer: (A) and (C)

22. A particle is thrown with a speed  $v$  from a point  $O$  at an angle  $\theta$  with the horizontal plane such that it passes through the point  $P$  at a height of  $1\text{ m}$  and horizontal distance of  $5\text{ m}$  from  $O$ , as shown in the figure. If acceleration due to gravity is  $g\text{ ms}^{-2}$ , then the correct statement(s) is/are:



- A) If  $\theta = 45^\circ$ , then  $v = \frac{5\sqrt{g}}{2}\text{ ms}^{-1}$ .
- B) If  $\theta = 45^\circ$ , the particle reaches its maximum height before it reaches  $P$ .
- C) If  $\theta = 30^\circ$ , the particle reaches its maximum height before it reaches  $P$ .
- D) If  $\theta = \tan^{-1}\left(\frac{1}{5}\right)$ , then  $v = 125\sqrt{g}\text{ ms}^{-1}$ .

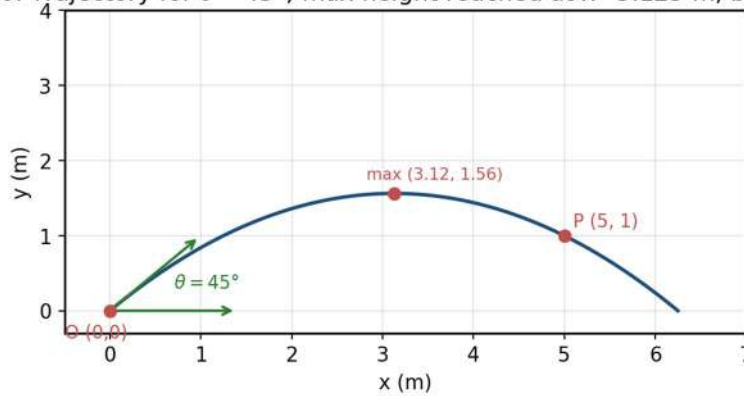
ANS :AB

SOL :



Projectile passing through  $P(5m, 1m)$

Q6: Trajectory for  $\theta = 45^\circ$ ; max height reached at  $x \approx 3.125$  m, before P



### Trajectory equation

$$y = x \tan \theta - \frac{gx^2}{2v^2 \cos^2 \theta}$$

At  $(x, y) = (5, 1)$ :

$$1 = 5 \tan \theta - \frac{25g}{2v^2 \cos^2 \theta}$$

(A)  $\theta = 45^\circ$

Substituting,

$$1 = 5 - \frac{25g}{v^2} \Rightarrow v^2 = \frac{25g}{4} \Rightarrow v = \frac{5\sqrt{g}}{2}$$

(B) Max-height position for  $\theta = 45^\circ$

$$x_{\max} = \frac{v^2 \sin \theta \cos \theta}{g} = \frac{v^2}{2g} = \frac{25}{8} = 3.125 \text{ m} < 5 \text{ m.}$$

Particle reaches its peak *before* P.

(C)  $\theta = 30^\circ$ : max height after P?

Solving (\*) with  $\tan 30^\circ = 1/\sqrt{3}$  gives  $v^2 \approx 8.83g$ . Then

$$x_{\max} = \frac{v^2 \sin 60^\circ}{2g} \approx 3.82 \text{ m} < 5 \text{ m.}$$

Max height occurs *before*  $P$ . **FALSE.**

(D)  $\theta = \tan^{-1}(1/5)$

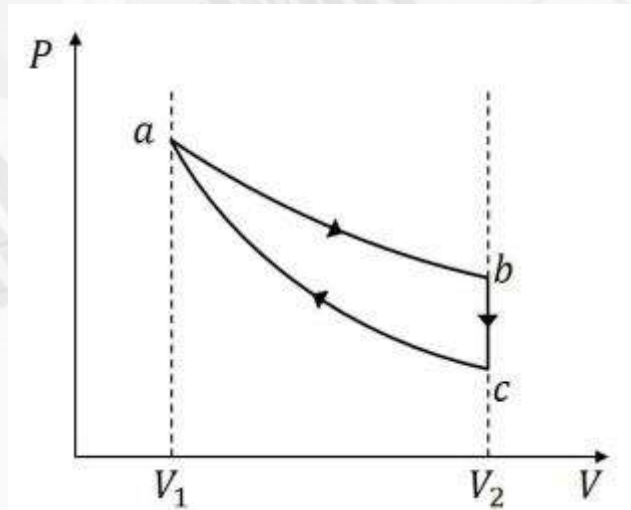
The launch direction is exactly along the line  $OP$ . Gravity drops the projectile below this line, so it cannot reach  $P$  for any finite  $v$ . Explicitly,  $(*)$  becomes  $1 = 1 - 13g/v^2$ , demanding  $v \rightarrow \infty$ , **FALSE.**

Answer: (A) and (B)

23. A quasi-static cycle of a monoatomic ideal gas contains an isothermal process ( $ab$ ), followed by an isochoric process ( $bc$ ) and an adiabatic process ( $ca$ ) as shown in the figure. The volumes of the gas are  $V_1$  and  $V_2$  at  $a$  and  $b$ , respectively. If the cycle has heat input  $Q_{in}$  and output  $Q_{out}$ , then the efficiency of the cycle is defined as

$$\eta = \frac{Q_{in} - Q_{out}}{Q_{in}}. \text{ The correct statement(s) is/are:}$$

[Given:  $\ln 2 \approx 0.7$ ]



- A) If  $V_2 / V_1 = 8$ , the heat released in the process  $bc$  is smaller than the heat absorbed in the process  $ab$ .
- B) For a given value of  $V_2 / V_1$ ,  $\eta$  does not depend on the temperature of the isothermal process.
- C) If  $V_2 / V_1 = 8$ , then the temperature of the gas at  $a$  is 4 times the temperature of the gas at  $c$ .
- D) If  $V_2 / V_1 = 8$ , then the pressure of the gas at  $a$  is 4 times the pressure of the gas at  $b$ .

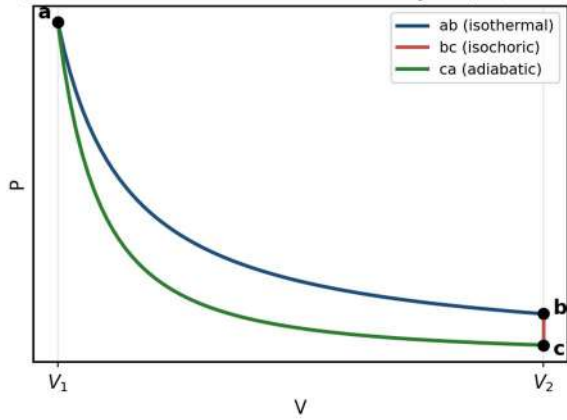


ANS : ABC

SOL :

**Monoatomic gas cycle: isothermal–isochoric–adiabatic**

Q7: Isothermal–isochoric–adiabatic cycle ( $V_2/V_1 = 8$ )



**Temperature at c (adiabat  $ca, \gamma = 5/3$ )**

$$T_c V_2^{\gamma-1} = T V_1^{\gamma-1} \Rightarrow T_c = T \left( \frac{V_1}{V_2} \right)^{2/3}$$

(C)  $V_2 / V_1 = 8$

$$T_c = T \cdot 8^{-2/3} = \frac{T}{4} \Rightarrow T_a = 4T_c$$

**(A) Heat comparison**

$$Q_{ab} = nRT \ln 8 = 3nRT \ln 2 \approx 2.10nRT,$$

$$|Q_{bc}| = nC_V \left( T - \frac{T}{4} \right) = \frac{3nR}{2} \frac{3T}{4} = 1.125nRT.$$

So  $|Q_{bc}| < Q_{ab}$ .

**(B) Efficiency depends only on  $V_2 / V_1$**

$$\eta = 1 - \frac{(3/2) \left( 1 - (V_1/V_2)^{2/3} \right)}{\ln(V_2/V_1)},$$

no temperature appears.

**(D) Pressure ratio**

Isothermal  $a \rightarrow b: P_a V_1 = P_b V_2$ , so  $P_a / P_b = V_2 / V_1 = 8$ , not 4. **FALSE.**

Answer: (A), (B) and (C)



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24. The electric field associated with an electromagnetic wave travelling in vacuum is given by  $E_0 \sin(3y + 4z + \omega t) \hat{i}$ , where  $\omega$  is the angular frequency. All quantities are in SI units. The correct statement(s) about this wave is/are:

[Given: speed of light in vacuum  $c = 3 \times 10^8 \text{ ms}^{-1}$ .]

- A) The wave is travelling in  $-\frac{1}{5}(3\hat{j} + 4\hat{k})$  direction.  
 B) The magnitude of the wave vector is  $0.5 \text{ m}^{-1}$ .  
 C) The value of  $\omega$  is  $1.5 \times 10^9 \text{ rad s}^{-1}$ .  
 D) The magnetic field associated with this wave is given by

$$\frac{E_0}{c} \sin(3y + 4z + \omega t) (4\hat{j} - 3\hat{k}).$$

ANS : AC

SOL :

**EM wave**  $\vec{E} = E_0 \sin(3y + 4z + \omega t) \hat{i}$

**Wave vector and direction**

Phase  $\vec{k} \cdot \vec{r} + \omega t$  with  $\vec{k} = (0, 3, 4)$ , so  $|\vec{k}| = 5 \text{ m}^{-1}$ . The  $+\omega t$  sign makes the wave travel in  $-\hat{k}$ :

$$\hat{n}_{prop} = -\frac{1}{5}(3\hat{j} + 4\hat{k}).$$

(B)  $|\vec{k}| = 0.5 \text{ m}^{-1}$ ?

$$|\vec{k}| = \sqrt{9+16} = 5 \text{ m}^{-1}. \text{ FALSE.}$$

(C) **Angular frequency**

$$\omega = c|\vec{k}| = (3 \times 10^8)(5) = 1.5 \times 10^9 \text{ rad s}^{-1}.$$

(D) **Magnetic field**

$$\hat{E} \times \hat{B} = \hat{n}_{prop}. \text{ With } \hat{E} = \hat{i}:$$

$$\hat{B} = \frac{1}{5}(-4\hat{j} + 3\hat{k}), \vec{B} = \frac{E_0}{c} \sin(3y + 4z + \omega t) \frac{1}{5}(-4\hat{j} + 3\hat{k}).$$

Option (D) gives  $(4\hat{j} - 3\hat{k})$  (wrong sign) and omits the  $\frac{1}{5}$  factor (wrong magnitude).

**FALSE.**

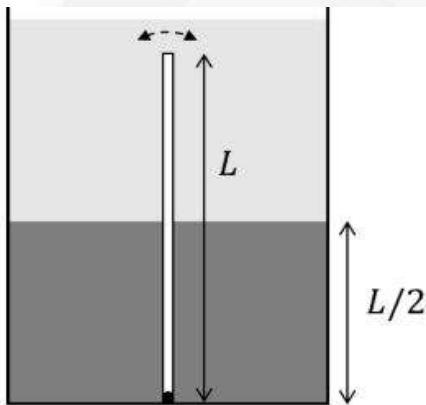
Answer: (A) and (C)

**SECTION-III**  
**(NUMERICAL VALUE)**

This section contains **FOUR (04)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme  
Full Marks : +4 If **ONLY** the correct integer is entered; Zero Marks : 0 In all other cases..

25. A tank contains two immiscible liquids of densities  $6\rho$  and  $2\rho$ . The higher density liquid is filled up to a height  $L/2$  from the bottom. A thin rod of density  $\rho$  and length  $L$  is fully immersed and hinged at the bottom so that it can oscillate freely, as shown in the figure. If the rod is slightly disturbed from its equilibrium, the time period of small oscillations is  $\frac{2\pi}{n} \sqrt{\frac{L}{g}}$ , where  $g$  is the acceleration due to gravity. The value of  $n$  is:

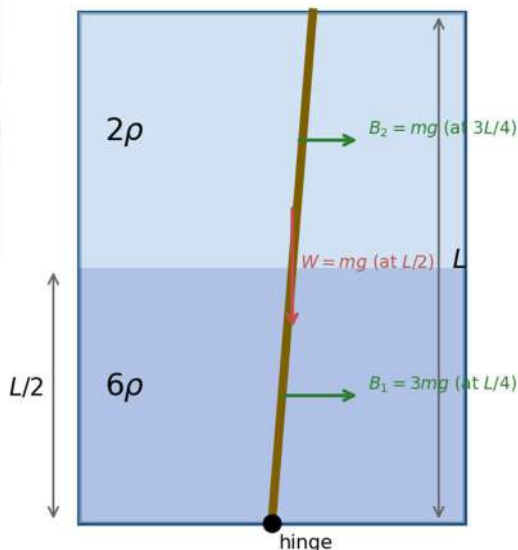


ANS :1.73

Hinged rod in two stratified liquids

SOL :

Q9: Rod hinged at bottom, in two stratified liquids





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V. AJAY REDDY  
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2025



REDDI ANIL  
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**Setup**

Rod of mass  $m = \rho AL$  hinged at the bottom;  $I_{hinge} = mL^2 / 3$ . The lower half is in liquid of density  $6\rho$ , the upper half in  $2\rho$ .

**Torques about the hinge for small  $\theta$**

- Weight:  $\tau_g = (mg)(L/2)\sin\theta$  (destabilising)
- Lower buoyancy  $B_1 = 3mg$  at  $L/4$ :  $\tau_1 = (3mg)(L/4)\sin\theta$  : (restoring)
- Upper buoyancy  $B_2 = mg$  at  $3L/4$ :  $\tau_2 = (mg)(3L/4)\sin\theta$  : (restoring)

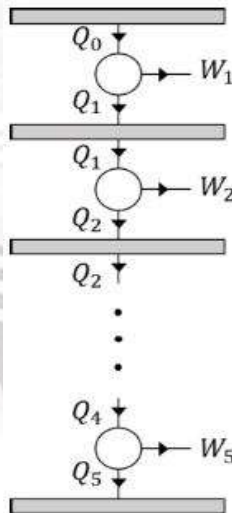
$$\tau_{net} = \left[ \frac{3}{4} + \frac{3}{4} - \frac{1}{2} \right] mgL \sin\theta = mgL\theta \text{ (restoring, small } \theta \text{)}$$

**Equation of motion and period**

$$\frac{mL^2}{3} \ddot{\theta} = -mgL\theta \Rightarrow \omega^2 = \frac{3g}{L},$$

$$T = 2\pi \sqrt{\frac{L}{3g}} = \frac{2\pi}{\sqrt{3}} \sqrt{\frac{L}{g}} \Rightarrow n = \sqrt{3} = 1.7320... \quad \text{Answer: } n = 1.73$$

26. As shown in the figure, five Carnot engines, each with efficiency  $\eta$  and same number of cycles per unit time, are operating between six heat reservoirs. The amount of heat released per cycle by one engine is completely absorbed by the next engine. Consider  $Q_0$  to be the amount of heat absorbed per cycle by the first engine and  $W$  as the amount of total work done by all the engines per cycle, then the net efficiency of the system is found to be  $\eta_{net} = \frac{W}{Q_0} = \frac{211}{243}$ . The value of  $\eta$  is:



ANS : 0.33



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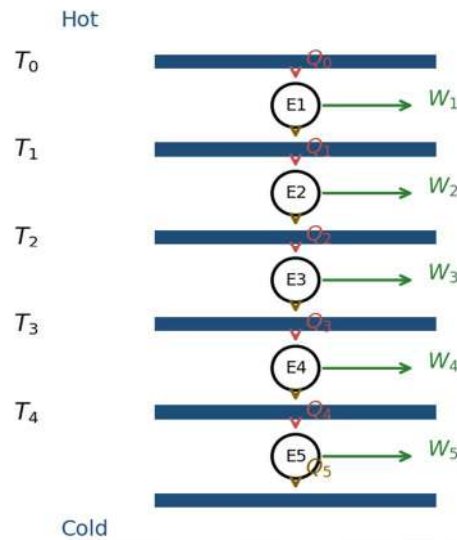
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SOL :

**Five cascaded Carnot engines**

Q10: Five Carnot engines in series — heat rejected by one is absorbed by the next



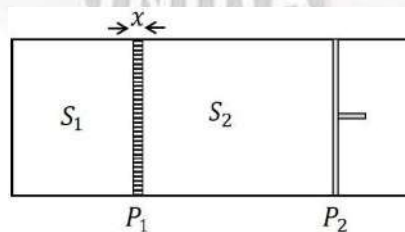
Each engine has efficiency  $\eta$ ; rejected heat becomes the next engine's input. After  $k$  engines,  $Q_k = Q_0(1-\eta)^k$ . Total work

$$W = Q_0 - Q_0(1-\eta)^5 \Rightarrow \eta_{net} = \frac{W}{Q_0} = 1 - (1-\eta)^5 = \frac{211}{243}$$

$$(1-\eta)^5 = \frac{32}{243} = \left(\frac{2}{3}\right)^5 \Rightarrow 1-\eta = \frac{2}{3} \Rightarrow \eta = \frac{1}{3}$$

Answer:  $\eta = 0.33$

27. As shown in the figure, an insulated container is fitted with a thermally conducting but immovable partition ( $P_1$ ) and a freely movable but thermally insulated piston ( $P_2$ ). The partition  $P_1$  with thermal conductivity  $K$ , cross sectional area  $A$  and width  $x$  divides the container into two sections,  $S_1$  and  $S_2$ , each containing one mole of a monoatomic gas. The piston  $P_2$  moves freely such that the gas in  $S_2$  is always at the atmospheric pressure. Initially, the difference between the temperatures of  $S_1$  and  $S_2$  is  $\Delta T_0$ . The time it takes for the temperature difference to become  $\frac{\Delta T_0}{2}$  is  $\frac{nxR}{KA}$ , where  $R$  is the universal gas constant. The value of  $n$  is:  
[Given:  $\ln 2 \approx 0.7$ ]





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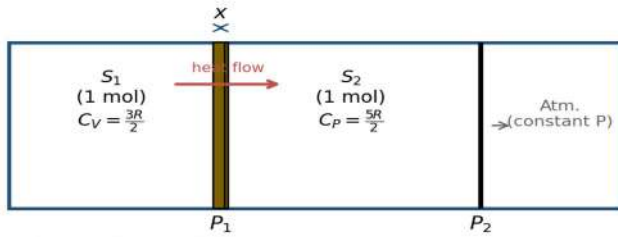
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ANS : 0.66

SOL :

**Heat conduction between two gas chambers**

Q11: Insulated container with conducting partition  $P_1$  and free piston  $P_2$



$S_1$  is at fixed volume, so  $C_1 = C_V = 3R/2$ .  $S_2$  is at fixed pressure (free piston), so  $C_2 = C_P = 5R/2$ . The conduction current is  $\dot{Q} = KA(T_1 - T_2)/x$ . Writing  $\Delta T = T_1 - T_2$ :

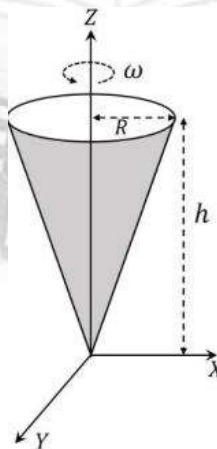
$$\frac{d(\Delta T)}{dt} = -\frac{KA}{x} \left( \frac{1}{C_1} + \frac{1}{C_2} \right) \Delta T = -\frac{KA}{x} \left( \frac{2}{3R} + \frac{2}{5R} \right) \Delta T = -\frac{16KA}{15Rx} \Delta T.$$

$$\Delta T(t) = \Delta T_0 \exp\left(-\frac{16KA t}{15Rx}\right).$$

For  $\Delta T_0/2$ :  $t = \frac{15Rx}{16KA} \ln 2 = \frac{15 \times 0.7}{16} \cdot \frac{Rx}{KA} = 0.65625 \cdot \frac{Rx}{KA}.$

Answer:  $n = 0.66$

28. A hollow, right circular cone of base radius  $R$  and height  $h$ , with its tip at the origin is rotating about the  $Z$ -axis with an angular velocity  $\omega$ , as shown in the figure. The cone carries a total charge  $Q$  uniformly distributed on its curved surface. The magnitude of magnetic field at a point  $(0,0,z)$ , where  $z \gg R$  and  $z \gg h$ , is  $\frac{n\mu_0 QR^2\omega}{4\pi z^3}$ . The value of  $n$  is:





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ANS :0.5

SOL :

**Far-field magnetic field of a rotating charged cone****Magnetic dipole moment**For a rotating surface charge,  $\mu = \frac{\omega}{2} \int r^2 dq$ .On the curved surface,  $dA \propto r dr$ , giving

$$\left\langle r^2 \right\rangle = \frac{\int_0^R r^2 (r dr)}{\int_0^R r dr} = \frac{R^4 / 4}{R^2 / 2} = \frac{R^2}{2}.$$

$$\text{Hence } \mu = \frac{\omega}{2} \cdot Q \cdot \frac{R^2}{2} = \frac{QR^2\omega}{4}.$$

$$\text{Far field on the axis } (Z \gg R) \quad B = \frac{\mu_0}{4\pi} \cdot \frac{2\mu}{z^3} = \frac{\mu_0}{4\pi} \cdot \frac{QR^2\omega}{2z^3}.$$

$$\text{Matching with } \frac{n\mu_0}{4\pi} \frac{QR^2\omega}{z^3} \text{ gives } n = 1/2. \quad \text{Answer: } n = 0.50.$$

### SECTION – IV (MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists: **List-I** and **List-II**.
- **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme:

*Full Marks:* +4 **ONLY** if the option corresponding to the correct combination is chosen;*Zero Marks:* 0 If none of the options is chosen (i.e. the question is unanswered);*Negative Marks:* -1 In all other cases

- 29.** List-I shows four configurations made of straight and semi-circular narrow tubes containing air. A sound wave of wavelength  $\lambda = 0.29m$  enters these structures at the point S and a sound detector is placed at D. Between the points S and D, the sound travels only through the tubes. List-II contains the possible smallest values of  $l$  (refer to the figures) for which the detector D records maximum amplitude. Ignore effects of sharp corners. [Given  $\cos(15^\circ) = 0.97$ ]



Choose the option that best describes the match between the entries in List-I to those in List-II.

	List-I		List-II
P)		1)	1.32 m
Q)		2)	1.19 m
R)		3)	0.51 m
S)		4)	0.29 m
		5)	0.13 m

A) P→4, Q→3, R→5, S→1

B) P→4, Q→3, R→5, S→1

C) P→3, Q→4, R→1, S→2

D) P→3, Q→4, R→5, S→2

ANS :D

SOL :









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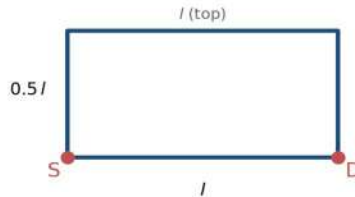
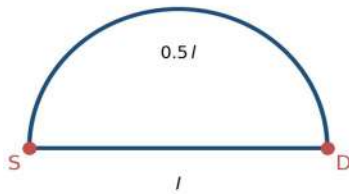
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**Sound interference through four tube configurations ( $\lambda = 0.29\text{ m}$ )**

Q13: Four sound-tube configurations ( $\lambda = 0.29\text{ m}$ )

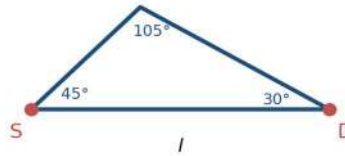
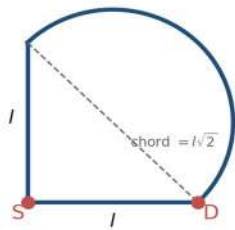
(P)  $\Delta l = (\pi/2 - 1)l \Rightarrow l \approx 0.51\text{ m}$

(Q)  $\Delta l = l \Rightarrow l = \lambda = 0.29\text{ m}$



(R)  $\Delta l = \pi l / \sqrt{2} \Rightarrow l \approx 0.13\text{ m}$

(S) using  $\sin 105^\circ = \cos 15^\circ = 0.97 \Rightarrow l \approx 1.19\text{ m}$



Constructive interference at  $D$  requires the path-length difference between the two routes to be an integer multiple of  $\lambda$ ; the smallest positive  $l$  takes one full wavelength of difference.

**(P) Semicircle of diameter  $l$  over a straight tube**

$$\Delta l = \pi l / 2 - l = (\pi / 2 - 1)l \Rightarrow l = \frac{\lambda}{\pi / 2 - 1} \approx 0.51\text{ m} \rightarrow (3).$$

**(Q) Rectangle of height  $0.5l$  over a straight tube**

$$\Delta l = (0.5l + l + 0.5l) - l = l \Rightarrow l = \lambda = 0.29\text{ m} \rightarrow (4).$$

**(R) Vertical leg  $l$  + semicircle with chord along the diagonal (length  $l\sqrt{2}$ )**

$$\Delta l = \left( l + \frac{\pi l}{\sqrt{2}} \right) - l = \frac{\pi l}{\sqrt{2}} \approx 2.22l \Rightarrow l \approx 0.13\text{ m} \rightarrow (5).$$

**(S) Triangle  $45^\circ - 105^\circ - 30^\circ$  on base  $l$**

With sine rule and  $\sin 105^\circ = \cos 15^\circ = 0.97$ :

$$\Delta l = l \frac{\sin 30^\circ + \sin 45^\circ}{\sin 105^\circ} - l \approx 0.2444l \Rightarrow l \approx 1.19\text{ m} \rightarrow (2).$$

Answer: (D)P $\rightarrow$ 3, Q $\rightarrow$ 4, R $\rightarrow$ 5, S $\rightarrow$ 2



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30. In the List-I, four optical effects are mentioned. The physical phenomena of light which are essential to describe these optical effects are given in List-II. Choose the option which describes the correct match between the entries in List-I to those in List-II.

	List-I		List-II
P)	Colorful sky in north polar region (Aurora Borealis)	1)	Dispersion and reflection
Q)	Partially polarized sun light	2)	Total internal reflection
R)	Rainbow	3)	Diffraction
S)	Dark and bright fringes	4)	Scattering of light by molecules in the atmosphere
		5)	Emission of radiation from oxygen and nitrogen atoms excited by charged particles

A) P→5, Q→4, R→1, S→3

B) P→4, Q→2, R→1, S→3

C) P→4, Q→1, R→2, S→3

D) P→5, Q→4, R→1, S→2

ANS : A

SOL :

*Optical phenomena ↔ physical mechanism*

- **(P) Aurora Borealis** — emission from atmospheric O and N atoms excited by charged particles → (5).
- **(Q) Partially polarised sunlight** — Rayleigh scattering by air molecules (light scattered at  $90^\circ$  is strongly polarised) → (4).
- **(R) Rainbow** — dispersion of white light in droplets combined with internal reflection → (1).
- **(S) Dark and bright fringes** — diffraction (from the available list) → (3).

Answer: (A) P → 5, Q → 4, R → 1, S → 3

31. List-I contains four conducting loops lying in the  $XY$  plane, as shown in the figures. The loops are rotating about  $Z$  axis passing through the point  $O$  with time period  $T$  in clockwise direction. The region  $x > 0$  contains a uniform magnetic field  $B$  in the  $+z$  direction. List-II contains the qualitative variation of the induced current ( $i$ ) for each of these loops.



Choose the option which describes the correct match between the entries in List-I to those in List-II.

	List-I		List-II
P)		1)	
Q)		2)	
R)		3)	
S)		4)	
		5)	

A) P → 5, Q → 4, R → 1, S → 3

B) P → 3, Q → 2, R → 5, S → 4

C) P → 3, Q → 2, R → 1, S → 4

D) P → 5, Q → 1, R → 2, S → 3

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ANS :C

SOL :

**Induced current in rotating planar loops**

Each loop rotates about  $z$  through  $O$  with period  $T$  (CW seen from  $+z$ ).  $\vec{B} = B\hat{z}$  only in  $x > 0$ . The induced current is  $i = -\frac{1}{R} \frac{d\Phi}{dt}$  with  $\Phi = B A_{x>0}$ .

**(P) Half-disk with diameter on  $+y$** 

Direct integration gives  $A_{x>0}(\theta) = R^2/8 (\sin 2\theta + 2\theta)$  for  $\theta \in [0, \pi/2]$ , then constant  $\pi R^2/8$  for  $\theta \in [\pi/2, \pi]$ , with mirror symmetry over the second half-rotation. The signal is a positive half-wave followed by a negative half-wave — matches **graph (3)**.

**(Q)  $60^\circ$  wedge straddling the  $y$ -axis (vertex at  $O$ )**

Each edge crosses the  $y$ -axis at a different instant, so the flux changes in stages, yielding multiple step transitions — matches **graph (2)**.

**(R)  $60^\circ$  wedge entirely in  $x < 0$ , one edge on  $+y$** 

Clean cycle: transition in ( $\approx T/6$ ), fully in  $x > 0$  ( $\approx T/3$ ), transition out ( $\approx T/6$ ), fully in  $x < 0$  ( $\approx T/3$ ).  $i(t)$ : + pulse, 0, - pulse, 0 — matches **graph (1)**.

**(S)  $60^\circ$  wedge symmetric about the  $x$ -axis**

By symmetry across the  $x$ -axis, equal amounts enter and leave  $x > 0$  at every instant, so

$$d\Phi/dt = 0 \text{ and } i(t) \equiv 0 \text{ — matches graph (4).}$$

Answer: (C) P  $\rightarrow$  3, Q  $\rightarrow$  2, R  $\rightarrow$  1, S  $\rightarrow$  4

32. List-I shows four planar structures made of uniform solid rods each of mass  $m$  and length  $l$ . In the List-II the possible moment of inertia of these structures about an axis  $OCO'$ , which lies in the plane of the structures, are given.



Choose the option that describes the correct match between the entries in List-I to those in List-II.

	List-I		List-II
P)		1)	$\frac{5}{4} ml^2$
Q)		2)	$\frac{1}{6} ml^2$
R)		3)	$\frac{1}{12} ml^2$
S)		4)	$\frac{2}{3} ml^2$
		5)	$\frac{1}{3} ml^2$

- A) P → 5, Q → 1, R → 4, S → 2      B) P → 1, Q → 3, R → 4, S → 2  
 C) P → 5, Q → 3, R → 2, S → 1      D) P → 5, Q → 4, R → 2, S → 1

ANS : A

SOL :

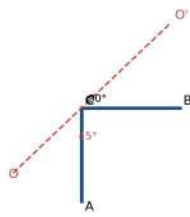
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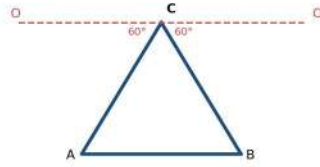
**Moment of inertia of four planar rod-structures**

Q16: Moment of inertia of four rod-structures about axis OCO'

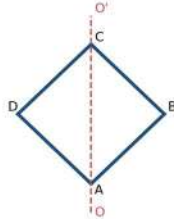
(P) axis at 45° through C  
 $I = 2 \cdot \frac{1}{3} ml^2 \sin^2 45^\circ = \frac{2}{3} ml^2 \rightarrow (5)$



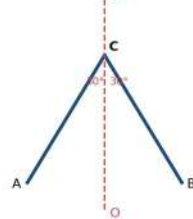
(Q) axis through top vertex, parallel to base  
 $I = 2 \cdot \frac{1}{3} ml^2 + m \cdot (l \sin 60^\circ)^2 = \frac{5}{4} ml^2 \rightarrow (1)$



(R) axis along the diagonal (each rod 45° to axis)  
 $I = 4 \cdot \frac{1}{3} ml^2 \sin^2 45^\circ = \frac{4}{3} ml^2 \rightarrow (4)$



(S) axis along axis of symmetry through C  
 $I = 2 \cdot \frac{1}{3} ml^2 \sin^2 30^\circ = \frac{1}{6} ml^2 \rightarrow (2)$



**Two general results used**

- Thin rod of mass  $m$ , length  $l$ , with one end on the axis, making angle  $\alpha$  with the axis (in the same plane):

$$I = \int_0^l (s \sin \alpha)^2 \frac{m}{l} ds = \frac{1}{3} ml^2 \sin^2 \alpha.$$

- Thin rod parallel to the axis at perpendicular distance  $h$ :  $I = mh^2$  (its own axial moment vanishes for an infinitesimally thin rod).

**(P) L-shape, axis through C at 45° to both rods**

$$I_P = 2 \cdot \frac{1}{3} ml^2 \sin^2 45^\circ = 2 \cdot \frac{1}{6} ml^2 = \frac{1}{3} ml^2 \rightarrow (5).$$

**(Q) Equilateral triangle, axis through top vertex C parallel to base**

Each slant rod (CA, CB) makes  $60^\circ$  with the axis; base AB is parallel to the axis at perpendicular distance  $h = l \sin 60^\circ = l\sqrt{3}/2$

$$I_Q = 2 \cdot \frac{1}{3} ml^2 \sin^2 60^\circ + m \left( \frac{l\sqrt{3}}{2} \right)^2 = 2 \cdot \frac{1}{4} ml^2 + \frac{3}{4} ml^2 = \frac{5}{4} ml^2 \rightarrow (1).$$

**(R) Square as a diamond, axis along the diagonal**

Each of the four sides has one end on the axis and makes  $45^\circ$  with it:

$$I_R = 4 \cdot \frac{1}{3} ml^2 \sin^2 45^\circ = \frac{4}{3} ml^2 \rightarrow (4).$$

**(S) Two rods at 30° to the symmetry axis through C**

$$I_S = 2 \cdot \frac{1}{3} ml^2 \sin^2 30^\circ = \frac{1}{6} ml^2 \rightarrow (2).$$

Answer: (A)P  $\rightarrow$  5, Q  $\rightarrow$  1, R  $\rightarrow$  4, S  $\rightarrow$  2



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## CHEMISTRY

Max Marks: 60

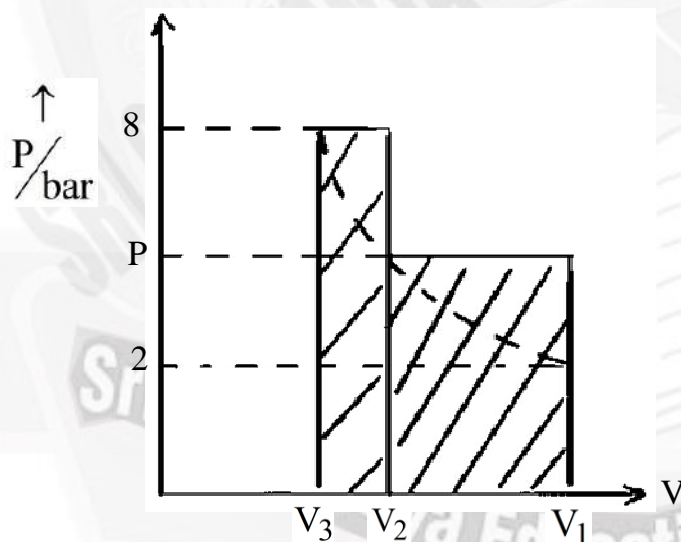
SECTION - I  
(SINGLE CORRECT ANSWER TYPE)This section contains **FOUR (04)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is the correct answer.
- For each question, choose the option corresponding to the correct answer.
- Answer to each question will be evaluated according to the following marking scheme:

**Full Marks** : +3 If **ONLY** the correct option is chosen;**Zero Marks** : 0 If none of the options is chosen (i.e. the question is unanswered);**Negative Marks** : -1 In all other cases

- 33.** An ideal gas (0.5 mol), initially at 2 bar pressure, is compressed at a constant temperature of 600 K in two steps: first, against a constant external pressure of  $P$  bar ( $2 < P < 8$ ), and then against constant external pressure of 8 bar. At each step, the compression is stopped only when the pressure of the gas becomes equal to the external pressure. The total work done on the gas in these steps is  $W$ . Considering all possible values of  $P$  ( $2 < P < 8$ ), and taking the gas constant as  $R$  (in  $\text{J K}^{-1} \text{mol}^{-1}$ ), the minimum value of  $|W|$  (in J) is

- A) 207 R                      B) 600 R                      C) 630 R                      D) 900 R

**Ans: B****Sol:** Using the ideal gas equation,  $PV = nRT$ ,

$$\text{We get } PV = 0.5R \times 600 = 300R \Rightarrow V = \frac{300R}{P}$$

$$\therefore V_1 = \frac{300R}{2} = 150R$$

$$V_2 = \frac{300R}{P}$$

$$V_3 = \frac{300R}{8} = 37.5R$$

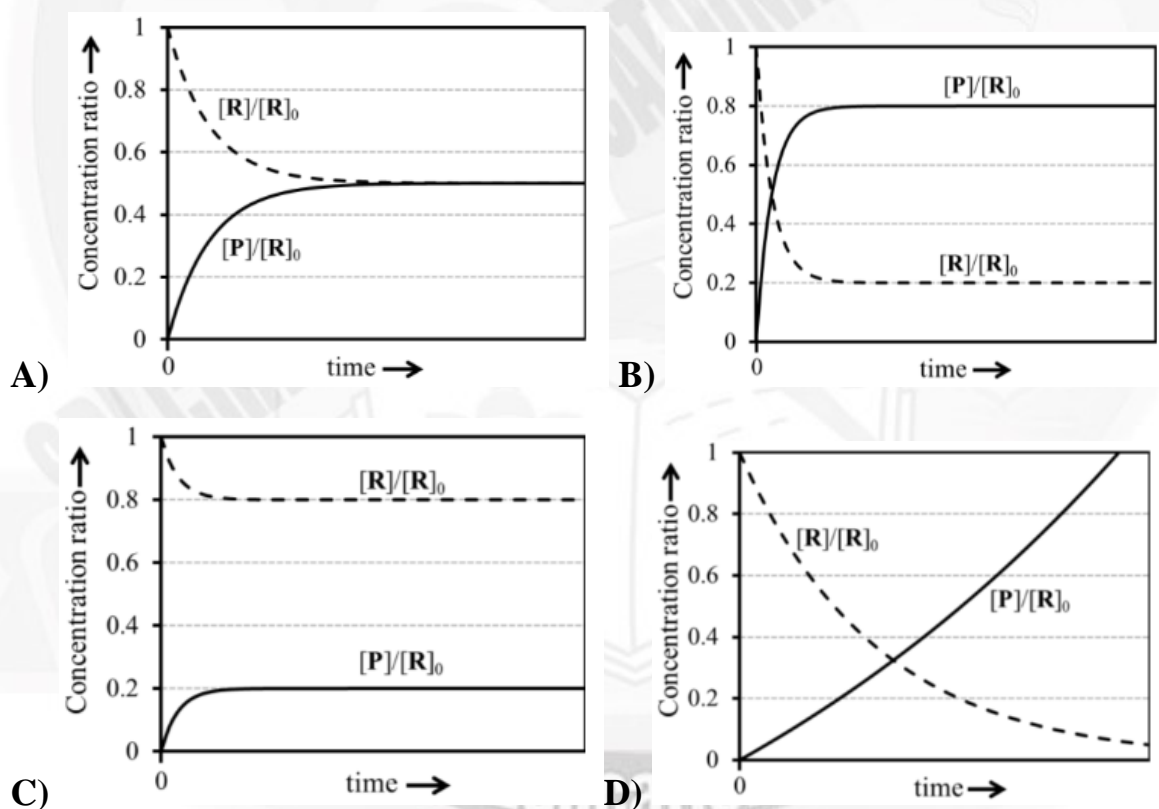


$$|W| = P \left[ 150R - \frac{300R}{P} \right] + 8 \left[ \frac{300R}{P} - 37.5R \right]$$

$$\Rightarrow |W| = 150RP - 300R + \frac{2400R}{P} - 300R \qquad \Rightarrow |W| = 150R \left[ P + \frac{16}{P} - 4 \right]$$

For minimum  $|W|$ ,  $P = 4$  &  $|W| = 600R$

34. For a reversible reaction  $R \rightleftharpoons P$ , at constant temperature, both the forward and the backward reactions are first order elementary reactions with rate constants  $k_f$  and  $k_b$ , respectively. At time zero, the concentration of R is  $[R]_0$  and the concentration of P is zero. At any given time,  $[R]$  and  $[P]$  are the concentrations of R and P, respectively. If  $k_b = 4k_f$ , the correct graphical representation of the reaction is



Ans: C



300/300  
RANKS  
JEE INDIAN  
2025



300/300  
RANKS  
JEE INDIAN  
2025



300/300  
RANKS  
JEE INDIAN  
2025



300/300  
RANKS  
JEE INDIAN  
2024



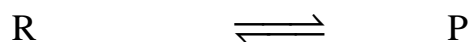
300/300  
RANKS  
JEE INDIAN  
2023



**HISTORY CREATED 300/300 IN JEE MAIN  
4<sup>TH</sup> YEAR IN A ROW**

**CONSISTENCY ISN'T LUCK. IT'S CULTURE.**

**Sol:** Let  $[P]_e$  and  $[R]_e$  be equilibrium concentrations of P and R



(ini)  $[R]_0$

(eq)  $[R]_0 - [P]_e$   $[P]_e$

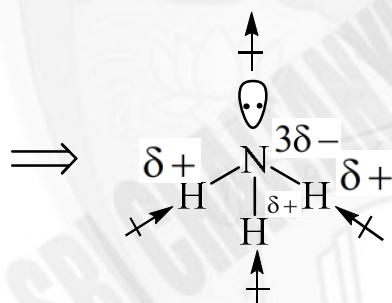
$$K_c = \frac{k_f}{k_b} = \frac{1}{4} = \frac{[P]_e}{[R]_0 - [P]_e} \Rightarrow \frac{[P]_e}{[R]_0} = \frac{1}{5} = 0.2 \quad \therefore \frac{[R]_e}{[R]_0} = \frac{4}{5} = 0.8$$

35. The correct order of dipole moments for the given species is

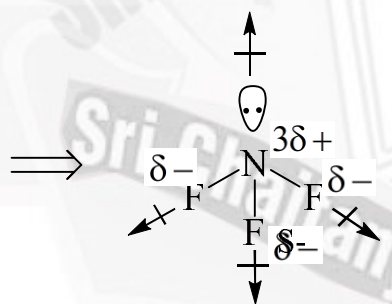
- A)  $BF_3 = NH_4^+ < NF_3 < NH_3$       B)  $BF_3 < NH_4^+ < NF_3 < NH_3$   
 C)  $NH_4^+ < BF_3 < NH_3 < NH_3$       D)  $BF_3 < NH_4^+ < NH_3 < NF_3$

**Ans: A**

**Sol:**



Resultant dipole vector of N – H bonds is reinforced by dipole vector of lone-pair.

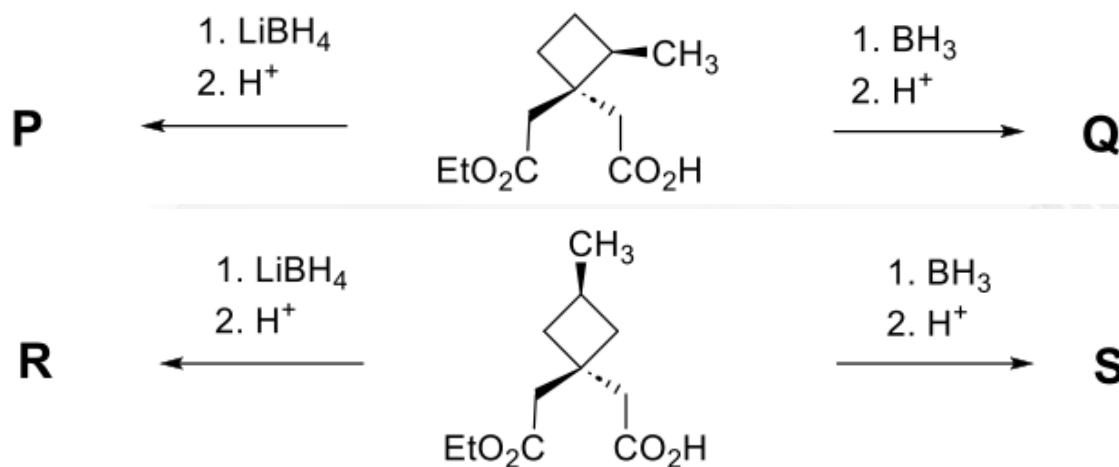


Resultant dipole vector of N – F bonds is opposed by dipole vector of lone-pair.

$\Rightarrow$  Resultant dipole moments of  $BF_3$  and  $NH_4^+$  species are zero as same bond moments are symmetrically distributed around central atom in both species.



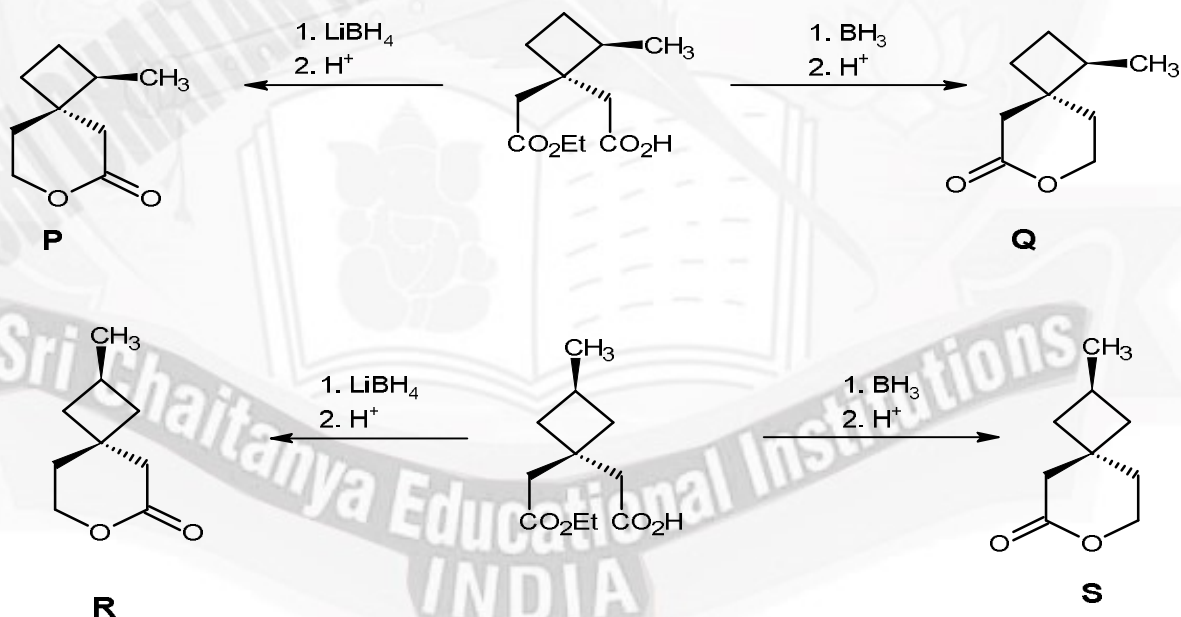
36. Considering  $\text{LiBH}_4$  reduces an ester group to the corresponding alcohol and does not reduce a carboxylic acid group, the correct statement about the major products P, Q, R and S is



- A) P & Q are identical, and R & S are diastereomers.  
 B) P & Q are diastereomers, and R & S are identical.  
 C) P & Q are diastereomers, and R & S are diastereomers.  
 D) P & Q are identical, and R & S are identical.

Ans: C

Sol:



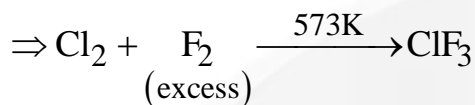
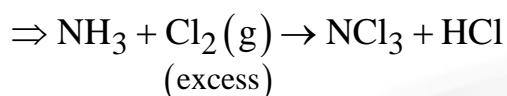
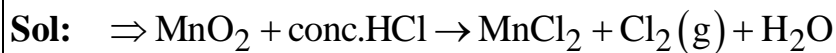
P and Q are stereoisomers that are not mirror images and hence are diastereomers.

R and S are achiral but are geometrical isomers.





Ans: AC



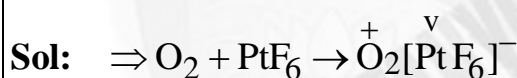
$\Rightarrow$  Negative charge density at lone pair of nitrogen of  $\text{NH}_3$  is higher than that of  $\text{NCl}_3$

$\Rightarrow \text{NCl}_3$  has trigonal pyramidal structure.

39. Reaction of  $\text{PtF}_6$  with oxygen ( $\text{O}_2$ ) gas results in the formation of an ionic compound,  $\text{X}^+\text{Y}^-$ . Correct statement(s) is(are)

- A) The bond order of  $\text{X}^+$  is 1.5.  
 B) Valence d-orbitals of the metal ion in  $\text{X}^+\text{Y}^-$  has 5 electrons.  
 C)  $\text{PtF}_6$  acts as an oxidant in this reaction.  
 D)  $\text{PtF}_6$  acts as a fluorinating agent in this reaction.

Ans: BC

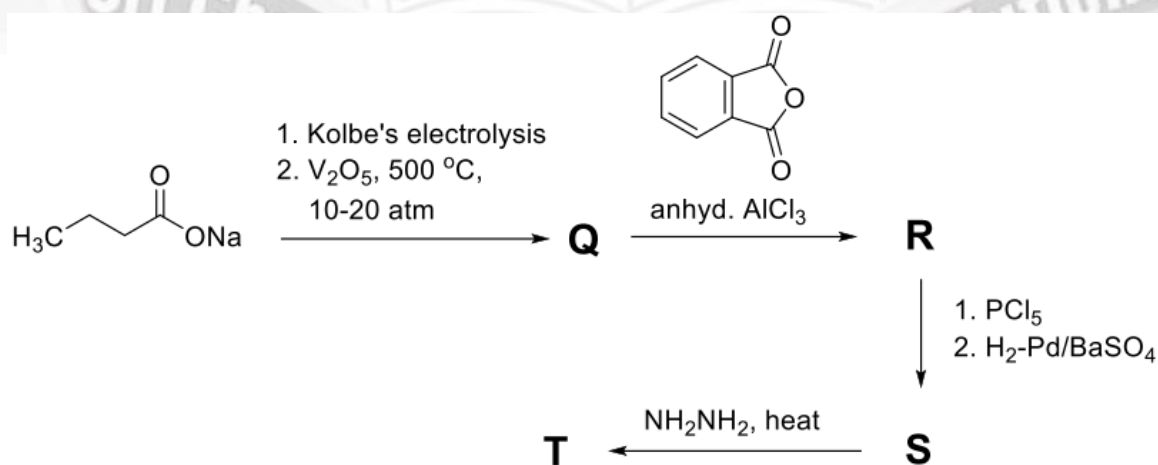


$\Rightarrow$  As oxidation state of Pt in  $\text{O}_2[\text{PtF}_6]$  is +5; hence there are five electrons in 5d orbitals of  $\text{Pt}^{\vee}$  ion.

$\Rightarrow \text{PtF}_6$  exhibits oxidizing character even at room temperature.

$\Rightarrow \text{PtF}_6$  does not oxidize  $\text{O}_2$  by fluorinating it.

40. In the following reaction sequence, Q, R, S and T are the major products.

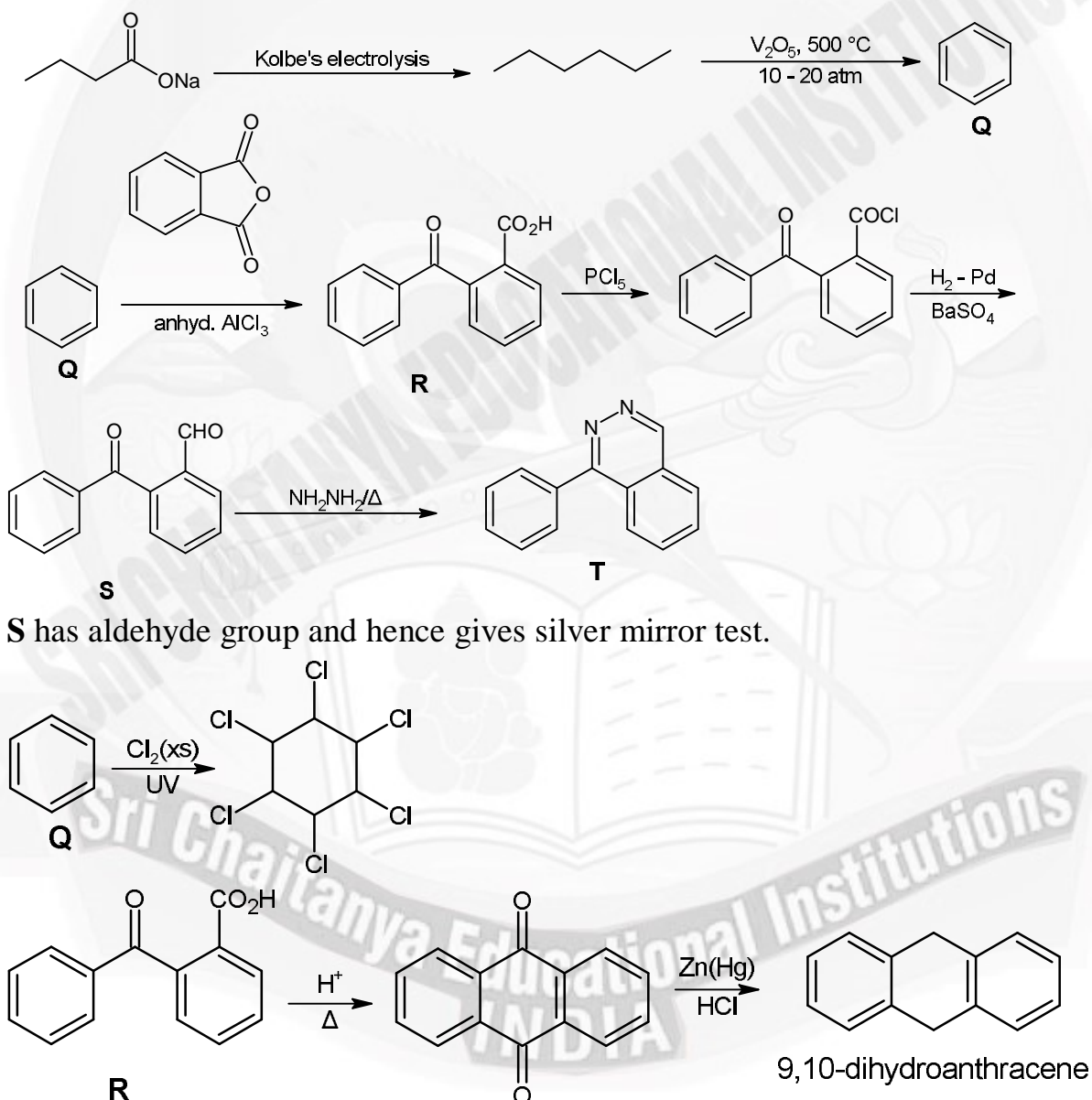


The correct statement(s) about Q, R, S and T is(are)

- A) S on warming with ammoniacal  $\text{AgNO}_3$  results in the formation of silver mirror.  
 B) Q on treatment with  $\text{Cl}_2$  (excess) / UI gives gamma-xane.  
 C) T is a heterocyclic compound.  
 D) R on acid catalyzed intramolecular cyclization followed by treatment with  $\text{Zn} - \text{Hg} / \text{HCl}$  gives 9,10-dihydroanthracene.

Ans: ABC

Sol:



S has aldehyde group and hence gives silver mirror test.



### SECTION-III (NUMERICAL VALUE)

This section contains **FOUR (04)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct integer corresponding to the answer using the mouse and the onscreen virtual numeric keypad in the place designated to enter the answer.
- Answer to each question will be evaluated according to the following marking scheme  
**Full Marks : +4 If ONLY the correct integer is entered; Zero Marks : 0 In all other cases..**

- 41.** Two cylinders, both fitted with frictionless pistons, are filled with mixtures of He and Ar gases. In the first cylinder, the masses of He and Ar are  $m_1$  and  $m_2$ , respectively. In the second cylinder, the masses of He and Ar are  $m_2$  and  $m_1$ , respectively. The molar mass of Ar is 10 times the molar mass of He. The external pressure applied by the piston on the first cylinder needs to be 5 times that on the second cylinder so that the volume of the gas mixtures in both the cylinders are equal at the same temperature. Assuming He and Ar behave like ideal gases, the value of  $(m_1 / m_2)$  is \_\_\_\_\_.

**Ans: 9.80**

**Sol:** At same  $V, T; P \propto n$

$P_1$	$P_2$
$m_{\text{He}} = m_1$ $m_{\text{Ar}} = m_2$	$m_{\text{He}} = m_2$ $m_{\text{Ar}} = m_1$

$$\Rightarrow [n_{\text{He}} + n_{\text{Ar}}]_1 = 5[n_{\text{He}} + n_{\text{Ar}}]_2$$

$$\Rightarrow \left[ \frac{m_1}{M} + \frac{m_2}{10M} \right] = 5 \left[ \frac{m_2}{M} + \frac{m_1}{10M} \right] \text{ (Where } M \text{ and } 10M \text{ are molar masses of He and Ar)}$$

$$\Rightarrow \frac{m_1}{m_2} = 9.80$$

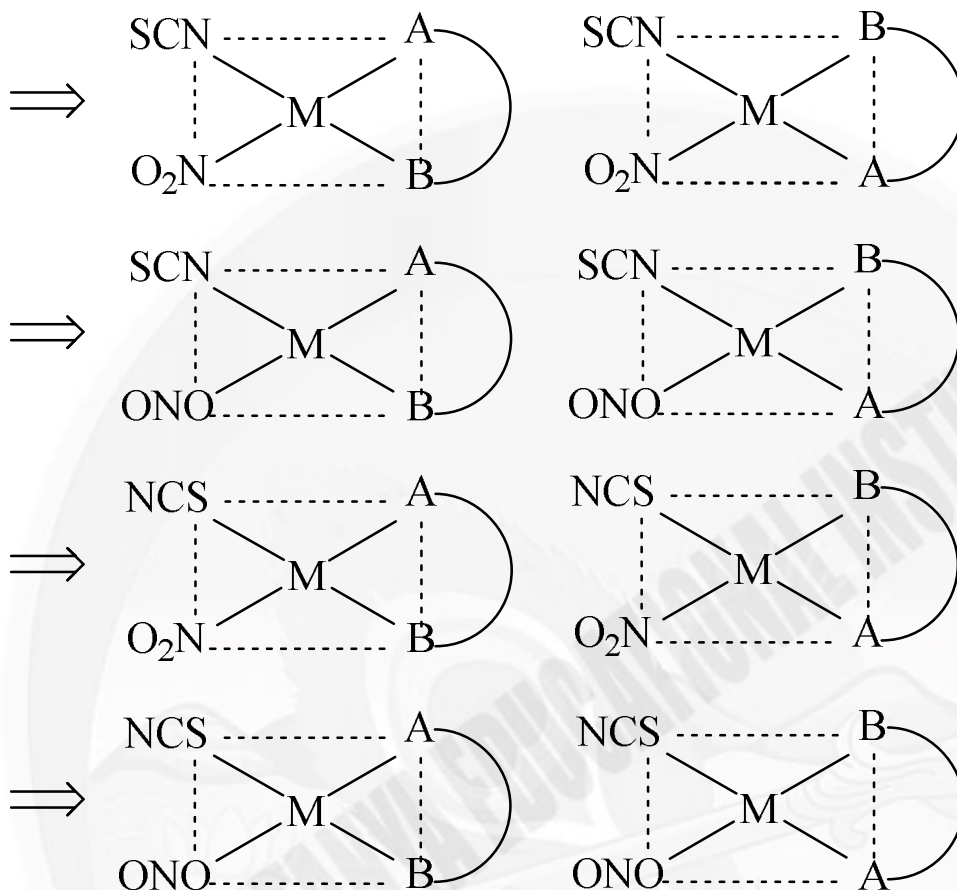
- 42.** The total number of all possible isomers for the square planar complex with formula  $K[M(\text{NCS})(\text{NO}_2)(\text{gly})]$  is \_\_\_\_\_.

( $M = \text{metal ion}$  and  $\text{gly} = \text{NH}_2\text{CH}_2\text{COO}^-$ )

**Ans: 8**



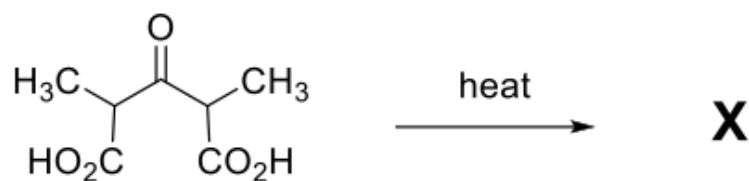
Sol:



Where  $AB \equiv H_2NCH_2COO^-$

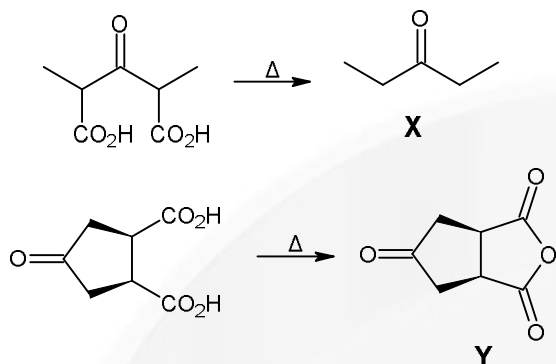
$\Rightarrow$  All are optically inactive due to having plane of symmetry.

43. The sum of total number of carbonyl groups ( $<C=O$ ) present in the major products X and Y in the following reactions is \_\_\_\_\_.



Ans: 4

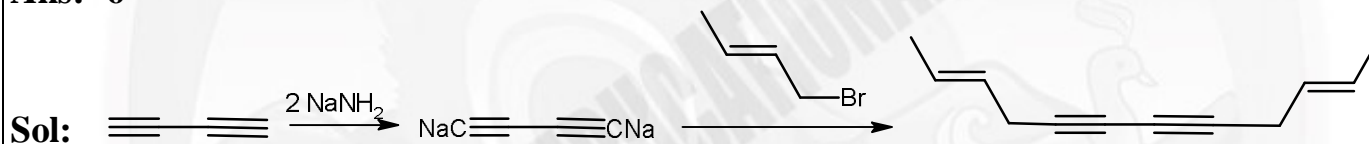
Sol:



X has 1 C=O group and Y has 3 C=O groups.

44. Treatment of buta-1,3-diyne with  $\text{NaNH}_2$  (2 equivalents), followed by reaction with excess of  $\text{trans-CH}_3\text{-CH=CH-CH}_2\text{-Br}$  gives X as the major product. The maximum number of carbon atoms that are collinear (in a straight line) in X is \_\_\_\_.

Ans: 6



### SECTION - IV (MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists: **List-I** and **List-II**.
- **List-I** has **Four** entries (P), (Q), (R) and (S) and **List-II** has **Five** entries (1), (2), (3), (4) and (5).
- **FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks: +4 ONLY if the option corresponding to the correct combination is chosen;

Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks: -1 In all other cases

45. **List-I** contains various physical/chemical processes, and **List-II** contains combinations of changes in enthalpy ( $\Delta H$ ) and entropy ( $\Delta S$ ). Match each entry in **List-I** to the appropriate entry in **List-II**, and choose the correct option.

List-I		List-II	
(P)	Physisorption	(1)	$\Delta H > 0$ and $\Delta S > 0$
(Q)	Diamond $\rightarrow$ Graphite	(2)	$\Delta H < 0$ and $\Delta S < 0$
(R)	Denaturation of protein	(3)	$\Delta H < 0$ and $\Delta S = 0$
(S)	Propene $\rightarrow$ Cyclopropane	(4)	$\Delta H > 0$ and $\Delta S < 0$
		(5)	$\Delta H < 0$ and $\Delta S > 0$

A) P  $\rightarrow$  2; Q  $\rightarrow$  3; R  $\rightarrow$  5; S  $\rightarrow$  4B) P  $\rightarrow$  4; Q  $\rightarrow$  3; R  $\rightarrow$  5; S  $\rightarrow$  1C) P  $\rightarrow$  2; Q  $\rightarrow$  5; R  $\rightarrow$  1; S  $\rightarrow$  4D) P  $\rightarrow$  2; Q  $\rightarrow$  5; R  $\rightarrow$  1; S  $\rightarrow$  3

Ans: C

Sol: Physisorption:  $\Delta H < 0; \Delta S < 0$

Diamond  $\rightarrow$  Graphite:  $\Delta H < 0; \Delta S > 0$

Denaturation of protein:  $\Delta H > 0; \Delta S > 0$

Propene  $\rightarrow$  Cyclopropane:  $\Delta H > 0; \Delta S < 0$

46. Consider the following species:



**List-I** contains different molecular shapes and **List-II** contains total number of species with the same molecular shapes from the given species. Match each entry in **List-I** with the appropriate entry in **List-II** and choose the correct option.

List-I		List-II	
(P)	See-saw	(1)	One
(Q)	T-Shaped	(2)	Two
(R)	Trigonal Planar	(3)	Three
(S)	Square Pyramidal	(4)	Four
		(5)	Zero

A) P  $\rightarrow$  1; Q  $\rightarrow$  2; R  $\rightarrow$  5; S  $\rightarrow$  3

B) P  $\rightarrow$  5; Q  $\rightarrow$  4; R  $\rightarrow$  2; S  $\rightarrow$  3

C) P  $\rightarrow$  3; Q  $\rightarrow$  2; R  $\rightarrow$  1; S  $\rightarrow$  4

D) P  $\rightarrow$  1; Q  $\rightarrow$  3; R  $\rightarrow$  5; S  $\rightarrow$  4

Ans: A

Sol: See-saw:  $\text{SF}_4 = 1$

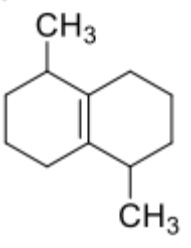
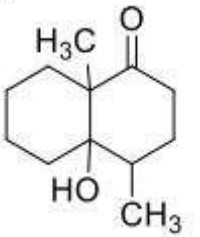
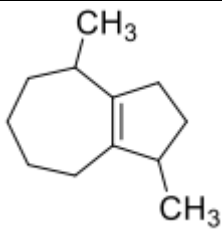
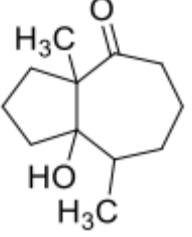
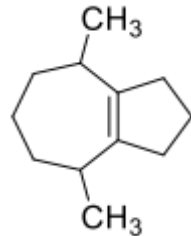
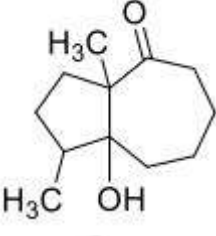
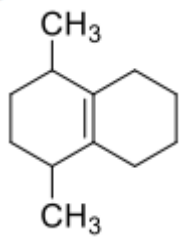
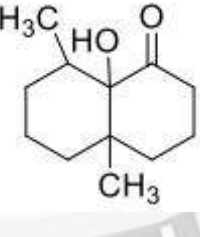
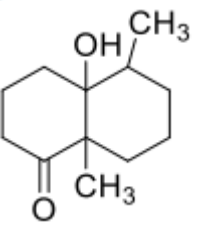
T-Shaped:  $\text{ClF}_3, \text{XeF}_3^+ = 2$

Trigonal Planar: No. of molecular species = 0

Square Pyramidal:  $\text{XeOF}_4, \text{ClF}_5, \text{XeF}_5^+ = 3$



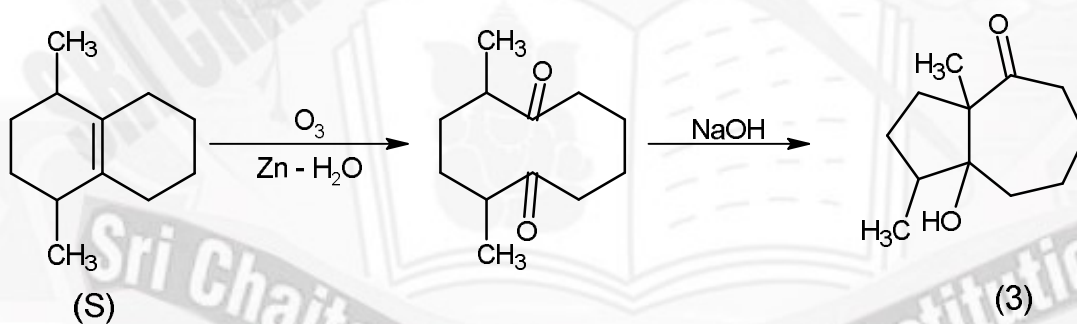
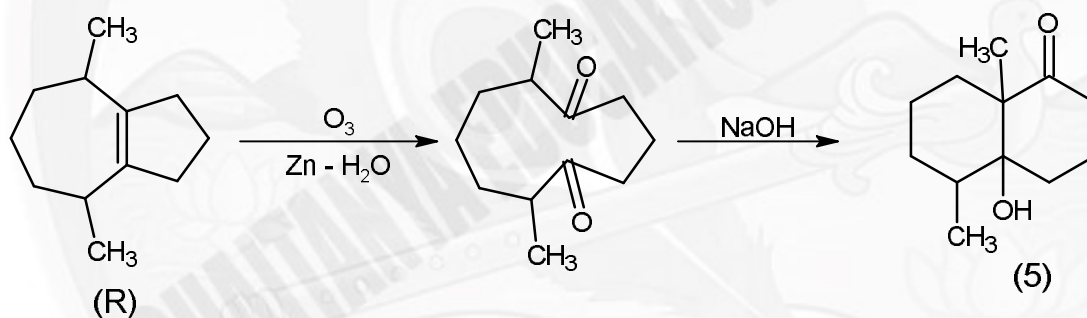
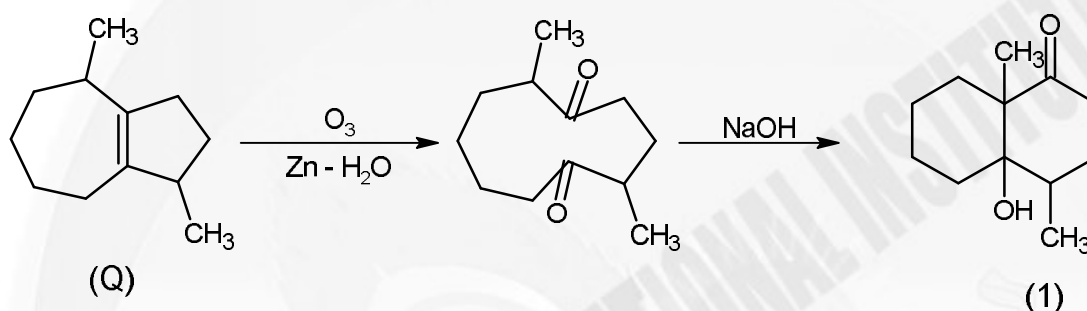
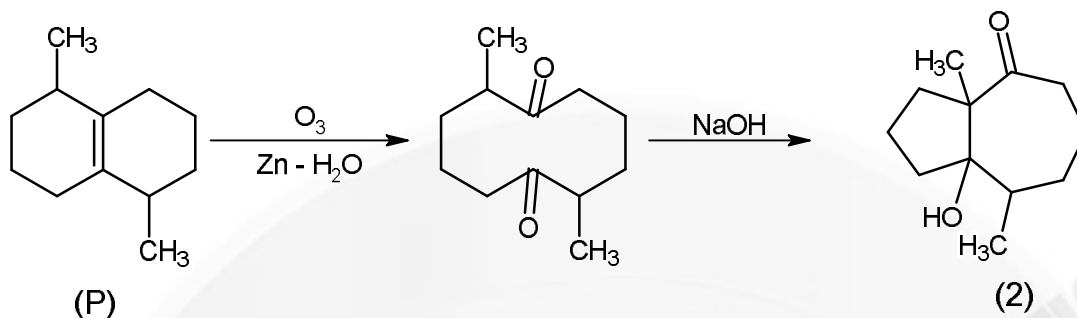
47. The List-II contains products obtained from the reaction of compounds in List-I with  $O_3 / Zn - H_2O$  followed by cyclization (via more stable enolate) in the presence of aqueous NaOH. Match each entry in List-I with appropriate entry in List-II and choose the correct option.

List-I		List-II	
(P)		(1)	
(Q)		(2)	
(R)		(3)	
(S)		(4)	
		(5)	

Ans: C



Sol:



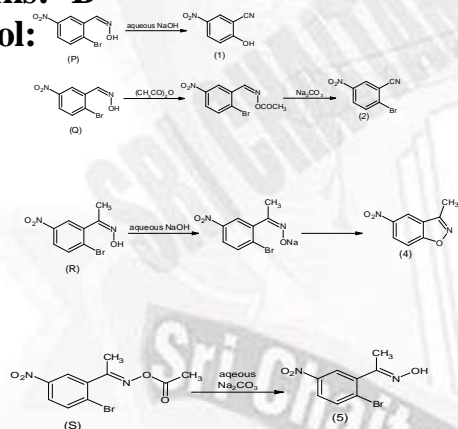
48. Match the major products obtained in the reactions given in List-I with the corresponding structures in List-II and choose the correct option.



List-I		List-II	
(P)		(1)	
(Q)		(2)	
(R)		(3)	
(S)		(4)	
		(5)	

Ans: B

Sol:



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# 304, Kasetty Heights, Ayyappa Society, Madhapur, Hyderabad-500081

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# LEADING BY MILES **SRI CHAITANYA** DOMINATES **JEE ADVANCED 2025**

**29 Ranks in Top 100 in All-India Open Category**



**4 Students in Top 11 in JEE-Advanced 2025, All India Open Category**

<b>16 RANK</b> DEVOUTTA MAJHI HT. No. 255053116*	<b>18 RANK</b> DHARMANA GNANA RUTVIK SAI HT. No. 256055278	<b>19 RANK</b> VANGALA AJAY REDDY HT. No. 256131009	<b>23 RANK</b> AKSH GOGI HT. No. 252071075*	<b>26 RANK</b> P HEMA SAI SURYA KARTHIK HT. No. 256033006	<b>27 RANK</b> SARKARSAMUDRA HT. No. 252071105*
<b>30 RANK</b> OM PRAKASH BEHERA HT. No. 252021018*	<b>32 RANK</b> SUNKARA SAI RISHANTH REDDY HT. No. 256165327	<b>34 RANK</b> DHRUBA JYOTHI PANJA HT. No. 252048248*	<b>35 RANK</b> BHAVESH JAYANTHI HT. No. 251043080	<b>36 RANK</b> ADVAY MAYANK HT. No. 252104113*	<b>37 RANK</b> KARMANYA GUPTA HT. No. 252081477*
<b>42 RANK</b> MD ANAS HT. No. 252046210*	<b>45 RANK</b> RAMIT GOYAL HT. No. 257001113*	<b>52 RANK</b> MAULIK JAIN HT. No. 252079407*	<b>54 RANK</b> GARV HT. No. 252056188*	<b>59 RANK</b> LARISSA HT. No. 252079071*	<b>60 RANK</b> ARYAN BALABADRULA HT. No. 256132077
<b>63 RANK</b> SAMYAJYOTI BISWAS HT. No. 252059455*	<b>64 RANK</b> AARUSH ANAND HT. No. 257006116*	<b>72 RANK</b> RUSHMITH BANDARI HT. No. 256168048	<b>78 RANK</b> KORIKANA RASAGNYA HT. No. 256057046	<b>87 RANK</b> LAKSHYA SHARMA HT. No. 252070079*	<b>91 RANK</b> AVANEESH BANSAL HT. No. 251113130*
<b>95 RANK</b> KAVYA AGGARWAL HT. No. 252079121*					

BELOW 100 ALL INDIA OPEN CATEGORY RANKS **> 29** | BELOW 500 ALL INDIA OPEN CATEGORY RANKS **> 113** | BELOW 1000 ALL INDIA OPEN CATEGORY RANKS **> 205** | BELOW 1000 ALL INDIA CATEGORY RANKS COUNT **> 745** | NUMBER OF QUALIFIED RANKS **4,212**